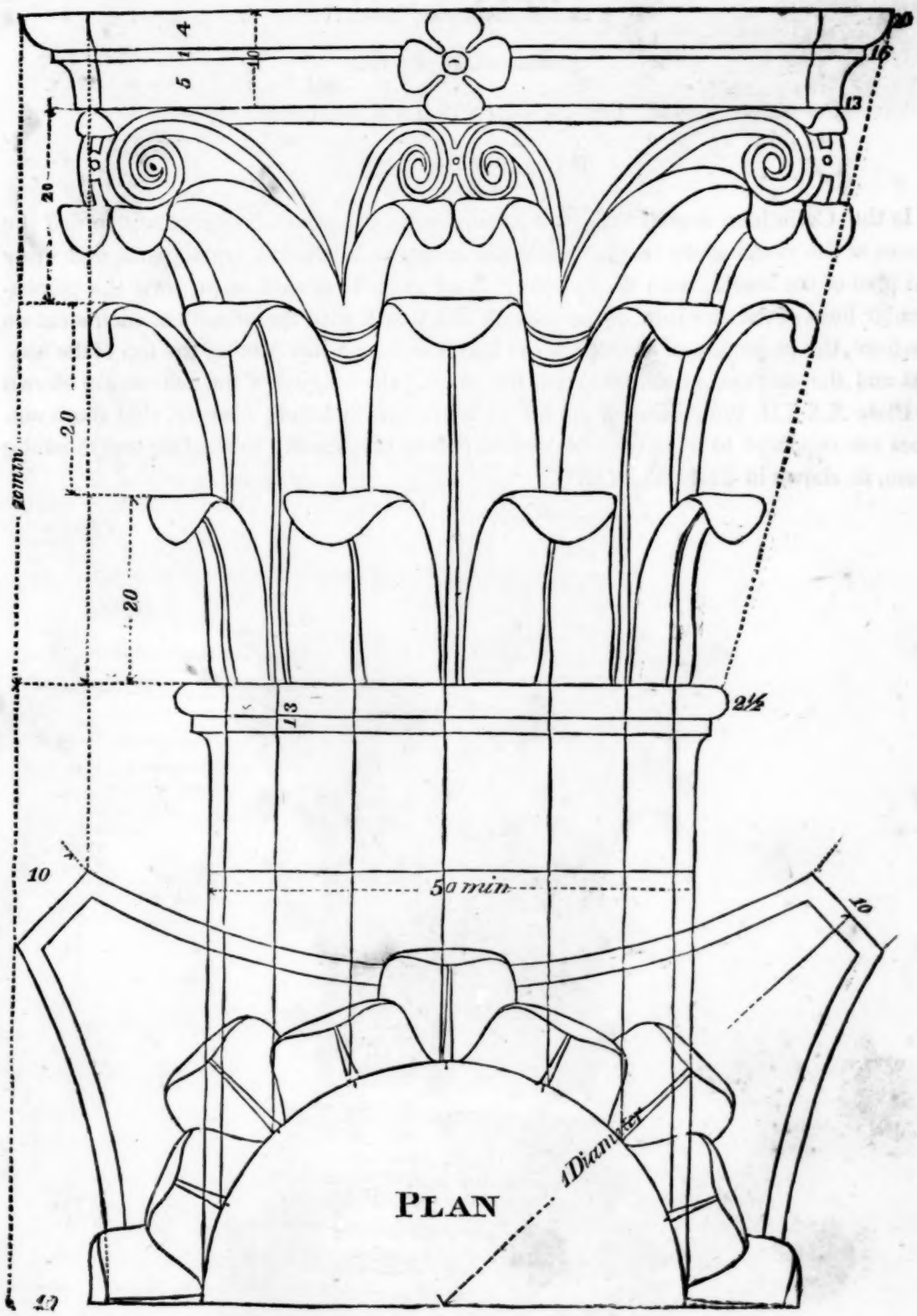
MECHANICS' MAGAZINE,

VOLUME VIII—No. 5.] NOVEMBER, 1836. [WHOLE NUMBER, 47.

Plate 31.



THE STUDENTS' INSTRUCTOR

IN DRAWING AND WORKING

THE FIVE ORDERS OF ARCHITECTURE.

BY PETER NICHOLSON, ARCHITECT.

(Continued from page 144.)

OF THE CORINTHIAN ORDER.

PLATE XXXI.

Is the Corinthian capital and plan in outline for the sake of clearness ; to find the places of the stems of the leaves, divide the semi-plan into eight equal parts, and draw the plan of the leaves, with their stems ; from the side of each stem draw the perpendicular lines of the elevation of the capital, and it will give the breadth of each stem on the front, the projection of the tops of the leaves is from a line joining the top of the abacus and the astragal at the bottom of the capital, the heights of the leaves are shown in Plate XXXII. the outline of the leaves are drawn by hand ; observe, that these outlines are supposed to be only in black-lead pencil, preparatory to shading and finishing them, as shown in Plate XXXII.

Plate 32.

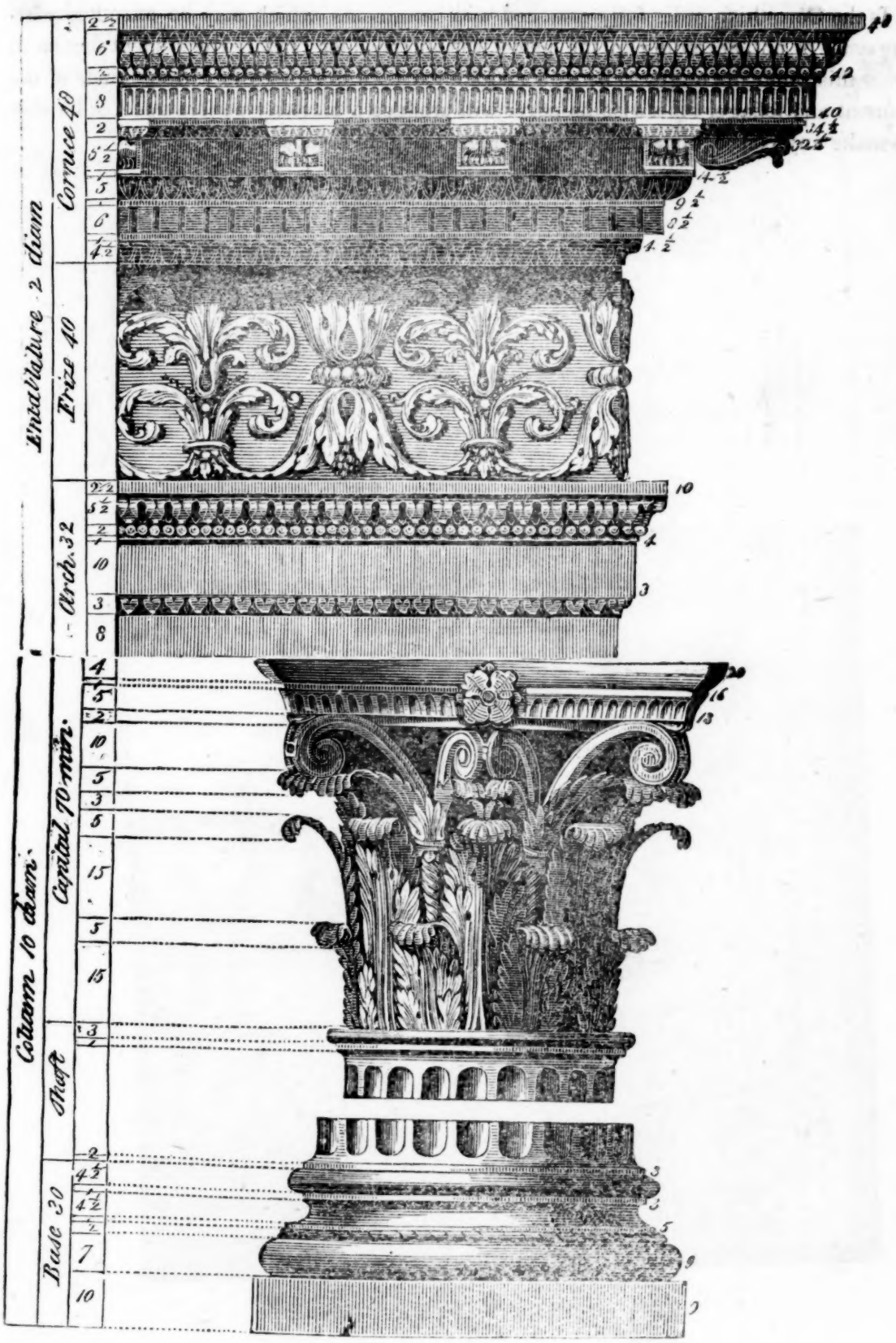

Entablature 2 diam
Cornice 40
Frize 40
Archt. 32
Column 10 diam.
Shaft
Capital 10 min.
Base 20

PLATE XXXII.

Is the Corinthian order fully enriched with ornaments, which may be executed with the order or not, according to the place it is intended for; before the student begins to draw this orddr, he ought to be well acquainted with drawing the various kinds of ornament and foliage, otherwise he never will produce a masterly performance, or be able to make any considerable figure in drawing so elegant a subject.

Plate 33.

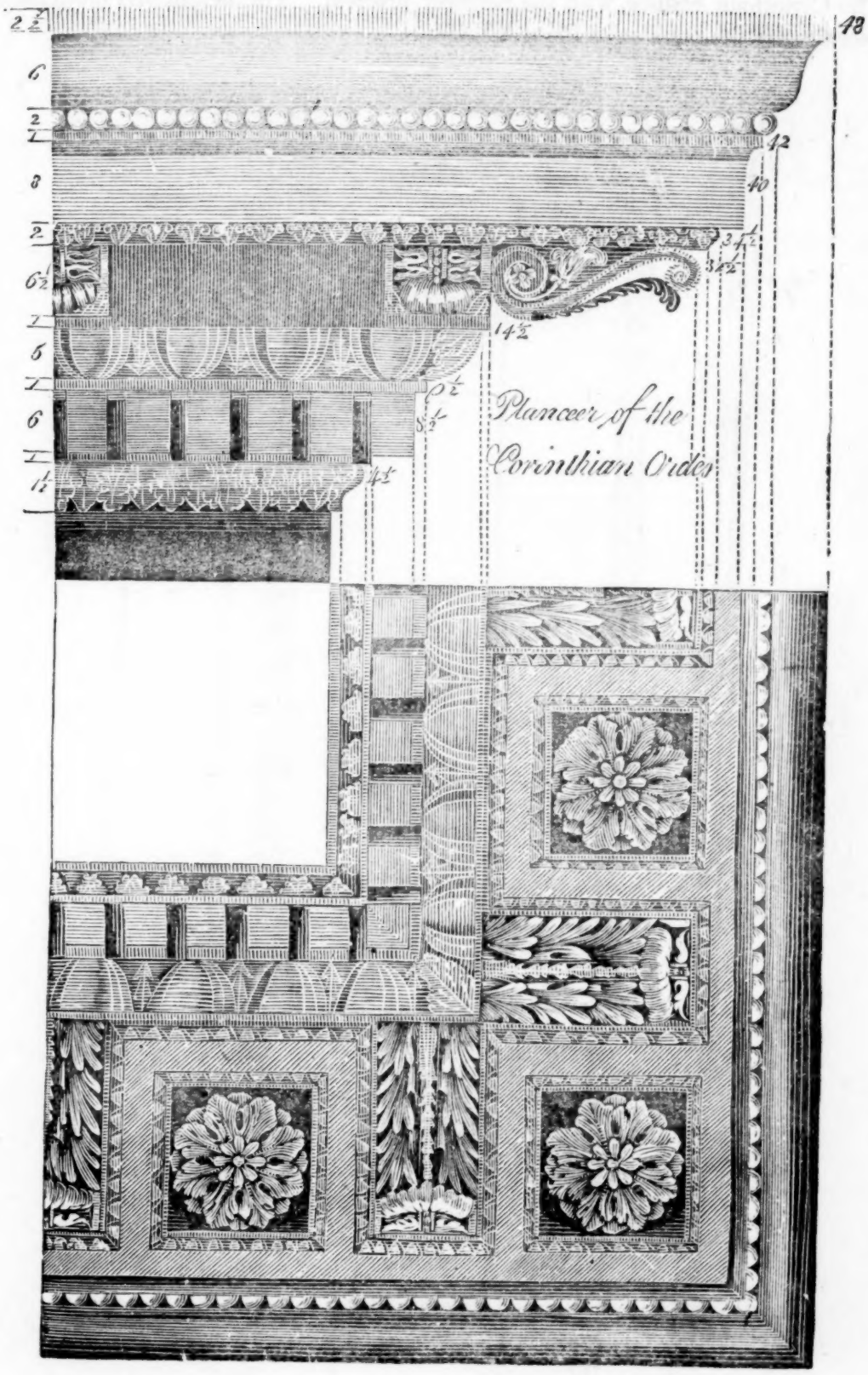


PLATE XXXIII.

The Corinthian cornice, with the planceer inverted. The height and projections of the cornice are the same as in Plate XXXII.

CORINTHIAN.

Plate 34.

Fig. 1. *Fig.* 2.

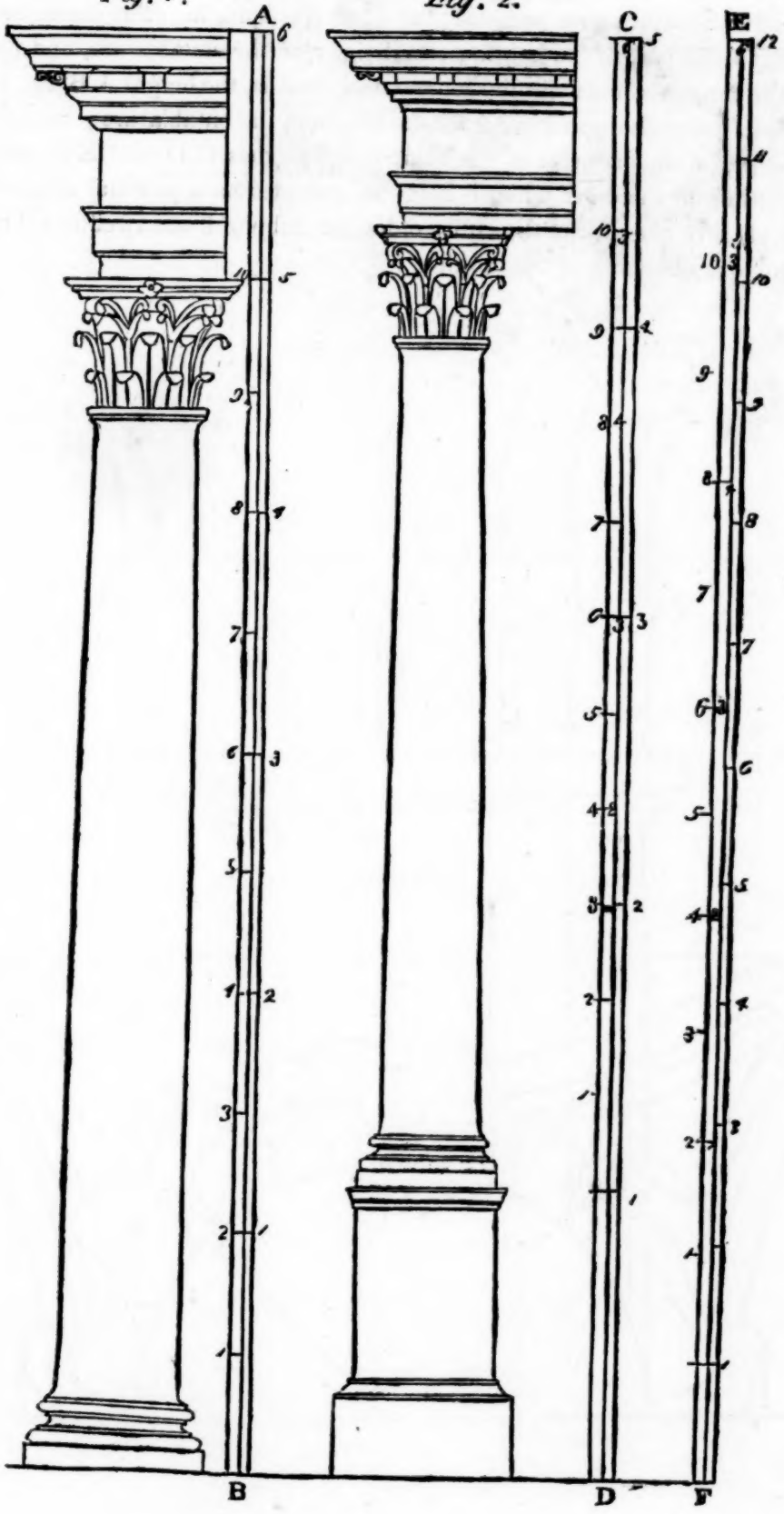
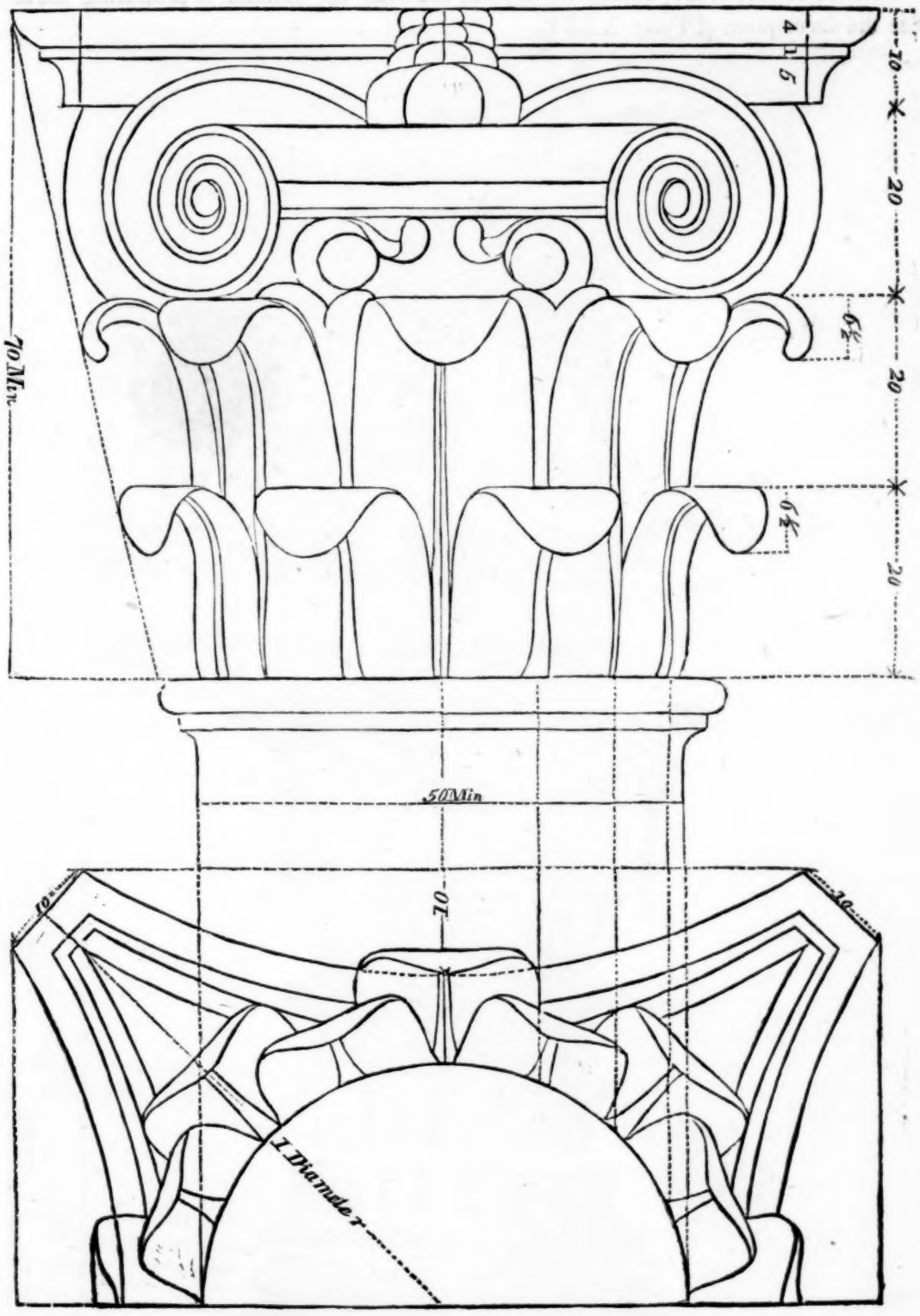


PLATE XXXIV.

Is the manner of drawing the Corinthian column with an entablature entire; or the column and entablature on a pedestal; or upon a subplinth. The diameter of the column is one-tenth part of its height; the height of the entablature, and pedestal, are found in the same manner as in the Ionic order; that is, the height A B, fig. 1. is divided into six equal parts, the upper one is for the height of the entablature; one half of which will of course, be the diameter of the column. The rods C D, and E F, show the methods of setting off the order when it is to be executed on a pedestal or on a subplinth; the pedestal takes one-fifth of the entire order, the subplinth one twelfth. The diameter of the column is one-tenth of its height.

Plate 35.

COMPOSITE CAPITAL.



OF THE COMPOSITE ORDER.

PLATE XXXV.

General outline of the Composite capital, showing the manner of projecting the same. See the description of Plate XXXI.

Plate 36.

COMPOSITE ORDER.

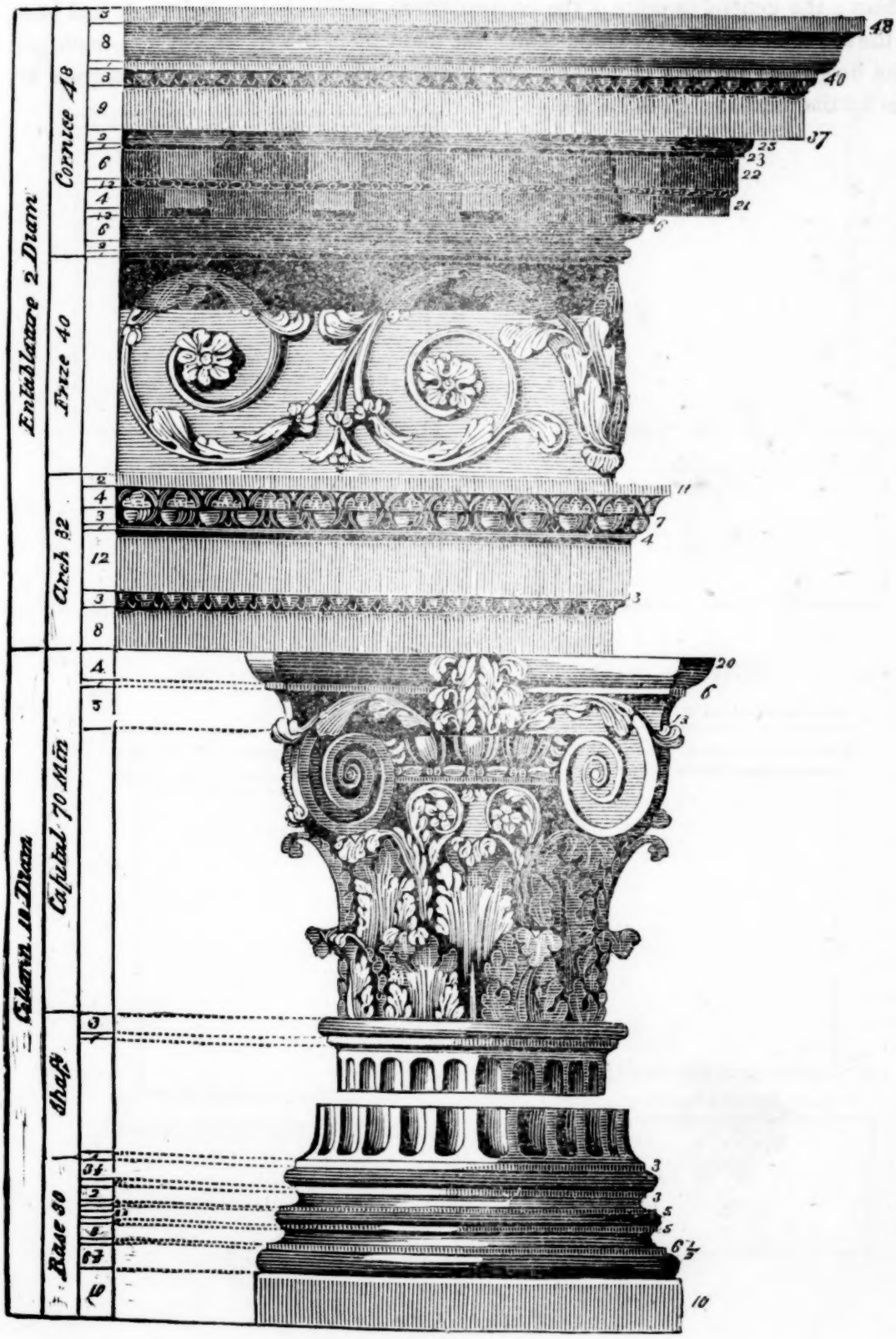


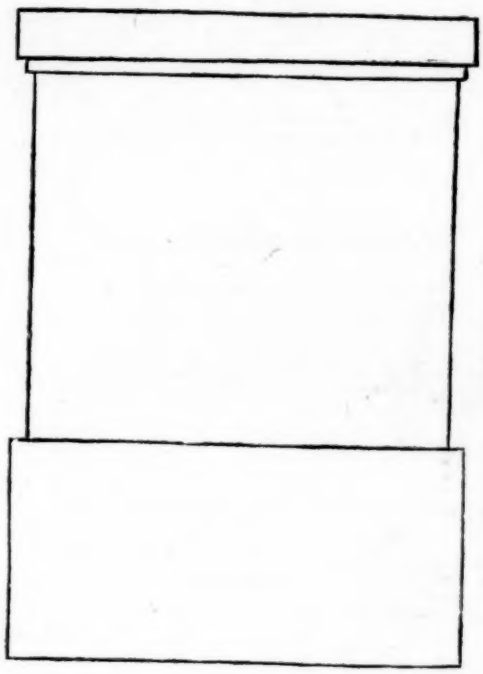
PLATE XXXVI.

Is the Composite order, so named because of its capital; the upper part being the same as the Ionic angular capital, and the lower part for leaves, the same as the Corinthian; the general heights of the cornice, frieze, architrave, capital, shaft and base, are the same as those of the Corinthian; the diameter of the column is one-tenth part of its height, as in the Corinthian; the heights and projections of the members are plain by the measures on the plate.

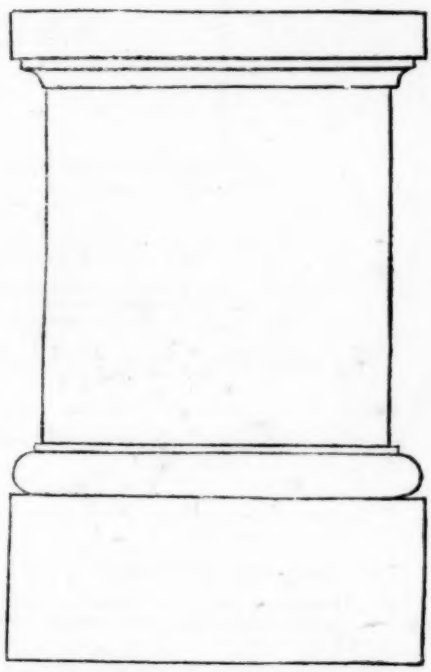
Plate 37.

PEDESTALS FOR FOUR OF THE ORDERS.

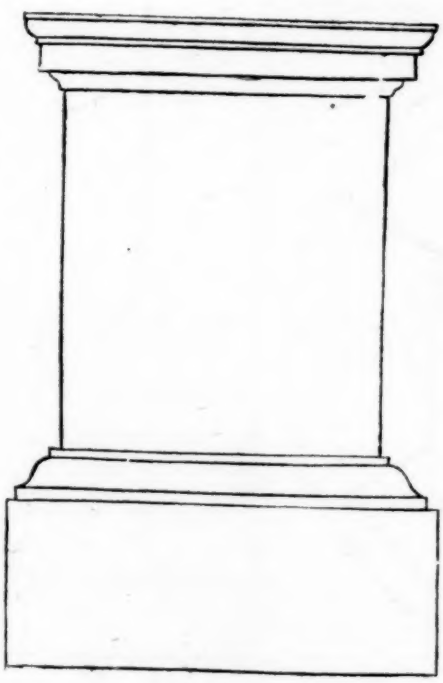
DORIC.



TUSCAN.



CORINTHIAN.



IONIC.

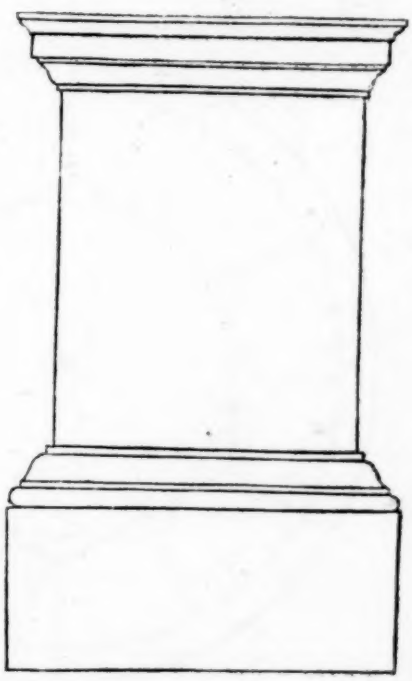
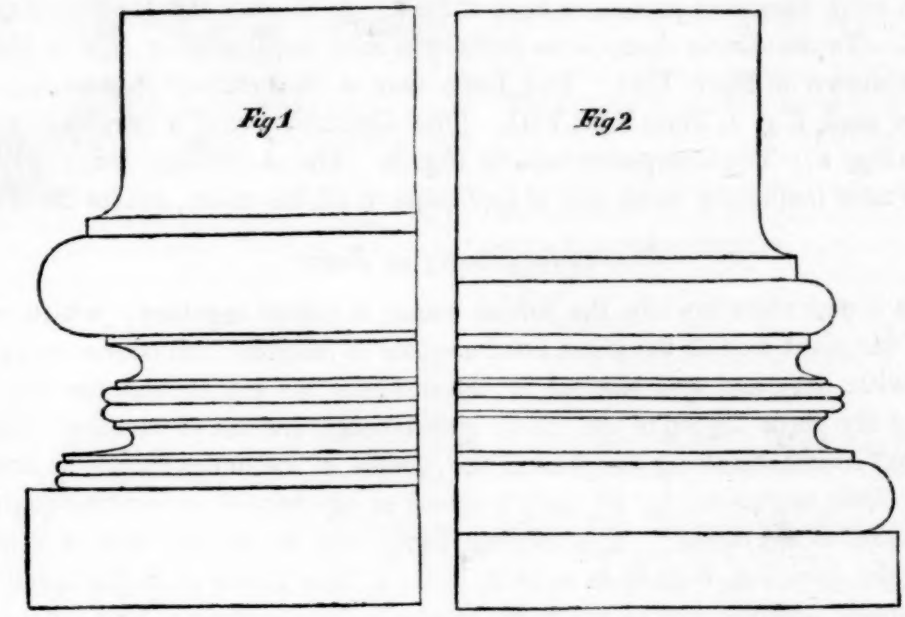


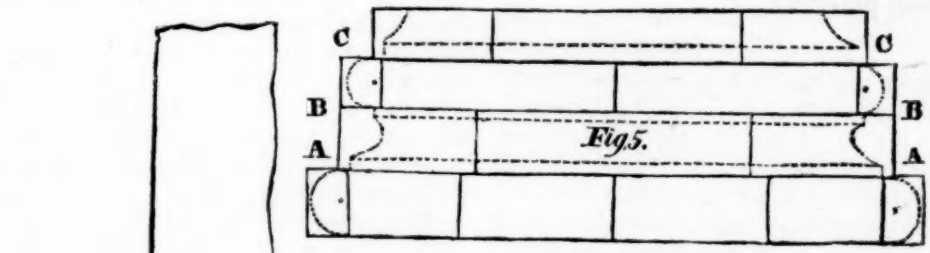
PLATE XXXVII.

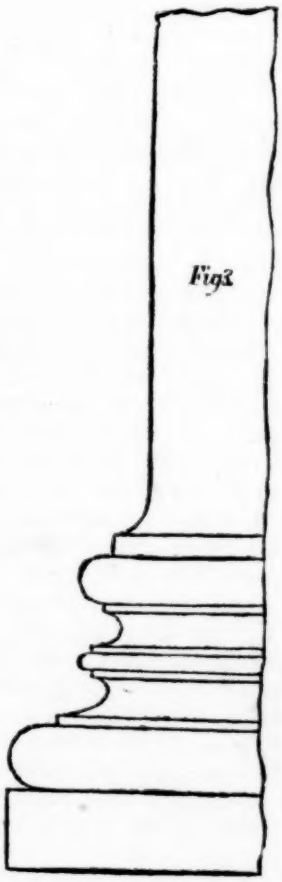
Contains pedestals for four of the orders. It has been already mentioned, that the pedestal of every order is one-fifth of its entire height; the die of the pedestal, or plain part, is in breadth equal to the plinth of the base of the column.

Plate 38.

BASES.







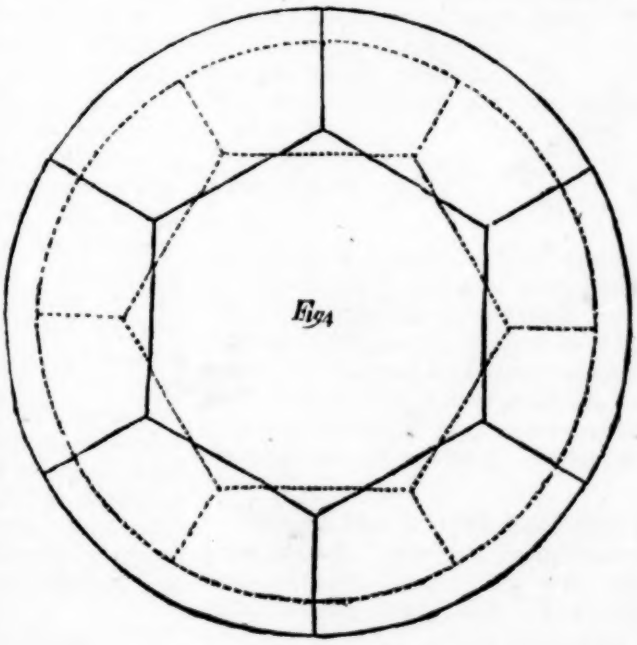


PLATE XXXVIII.

OF BASES.

To each order there is a particular kind of base. A Tuscan base is shwon to Plate IX. and X. To the Doric there is no particular base, but the Attic base is proper to be used as shown on Plate XIII. The Ionic base is of a clumsy appearance, and is very rarely used, Fig, 1, Plate XXXVIII. The Corinthian base is very elegant, as is shewn by Fig. 2. The Composite base is Fig. 3. The Attic base (Plate XIII. and XXIV.) is most frequently used, and is applicable to all the orders, except the Tuscan.

Method for Gluing up Bases.

Fig. 4 is a plan showing how the bottom course is mitred together; which must be done on a flat board, and all the joints fitted as close as possible: this course being glued together with care, and well blocked in the inside at the angles, and the glue being thoroughly dry, plane the top of the course quite smooth, and out of winding; then glue on the next course, breaking the joint in the middle of the under course, as shown by the dotted lines, and so on, for as many c ourses as are wanted; when thoroughly dry, it may be sent to the turner. The bedding joints may be on one side of a fillet, as shown in the elevation, Fig. 5, A A, B B, C C; a base glued up in this manner, will be the strongest possible, and be less liable to crack and split, than by any other method I have seen practised

HISTORY OF THE FOUNDATION OF THE BRITISH MUSEUM.

Sir,—As you have occasionally devoted some of your pages to the subject of our National Museum, with a view to its improvement, and the extension of its public utility, I venture to trasmit to you some particulars respecting its foundation, not generally known, and which are not to be found in the article "British Museum," lately published in the *Penny Cyclopedia*, and which common report attributes to the pen of Sir Henry Ellis. The following sketch has been compiled with great care, principally from contemporary writers, whose authenticity may be relied on.

I am, Sir,
Your obedient servant,
S. S.

June 1, 1836.

Sir Hans Sloane, the founder of the British Museum, one of the most eminent physicians and naturalists of the eighteenth century, of whom an interesting memoir may be found in the *Biographia Britannica*, was not only distinguished as a man of science, but also as a liberal and patriotic citizen. He was a governor of most of the metropolitan hospitals, to which he was not only a constant benefactor, but also left considerable sums to them at his death.—He set on foot the scheme of a dispensary for the poor, and gave to the Apothecaries' Company, a piece of ground at Chelsea for a botanic garden, who, "that their successors and posterity might never forget their common benefactor," caused a marble statue, by the celebrated Rysbrach, to be erected to his memory. Sir Hans Sloane was also instrumental in establishing the Foundling Hospital, and formed the plan for bringing up the children, which proved the best that could be devised. He was the first who introduced into England the general use of bark, which he applied successfully to the cure of many diseases. Sir Hans Sloane also gave a sanction to the practice of *inoculation*, by inoculating two of the princesses, which more effectually established this great discovery, than all the treatises that had been written on the subject. But the share he had in the foundation of the British Museum, will most effectually preserve his name from oblivion. Having, with great labor and expense, during the course of his long life,* collected a rich cabinet of medals, objects of natural history, &c., and a valuable library of printed books† and MSS. He bequeathed the whole to the public, on condition that the sum of 20,000*l.* should be paid to his executors, for the benefit of his family, but which, according to his own declaration, in a codicil to his will, made a short time before he died, was not a *fourth* part of the then intrinsic value of his Museum.* And it should be remembered, that the sum of 80,000*l.*, expended in the first half of the eighteenth century, in the purchase of MSS., rare books, coins, gems, antiquities, and other curiosities, would produce a very different result, in point of quantity and quality, from the same smount devoted to similar purposes, at the commencement of the nineteenth—when a single MS. was sold for 2,000*l* or 3,000*l*. It may be safely asserted, therefore, that 200,000*l*. would now scarcely purchase such a collection as Sir Hans Sloane's was in the year 1753.

The following list of articles, contained in Sir Hans Sloane's Museum, is given in the *Biographia Britannica*, (art. Sloane,) which was published in 1763, only four years after the opening of the Museum to the public; it is a curious and important record, and as it was probably communicated to the writer of Sir Hans's life, by an officer of the British Museum, it may, we think, be entitled to all the credit of an official document.

Medals and coins, ancient and modern,	22,000
Antiquities, &c., about	1,125
Seals, &c.,	268
Cameos and Intaglios, &c., about	700
Precious stones, agates, jaspers, &c.,	542
Crystals, spars, &c.,	1,864
Fossils, flints, and stones, &c.,	1,275
Metal, mineral ores, &c.,	2,725
Earths, sands, salts, &c.,	1,035
Bitumen, sulphurs, ambers, ambergris, &c.,	399
Tales, micæ, &c.,	388
Testacea, or shells,	5,834

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* He died in 1753, in his 92d year.

† A remarkable instance of Sir Hans Sloane's liberality, as regarded his library, is worthy of record. If he found that he possessed duplicates of any books which related to medicine, he was accustomed to present them to the college of physicians; and if they treated of other subjects, to the Bodleian library, a rare, and, we are afraid, solitary example of disinterestedness and devotion to the cause of literature and science.

* In the *Penny Cyclopedia*, 50,000*l.* is the sum named. But this is the amount mentioned by Sir Hans in his will, which was made in the year 1739. The compiler of this article could never have seen the codicils, or he would not have committed so gross an error.

Corals, sponges, &c.,	1,421
Echini, Echinites, &c.,	659
Asteriæ, trochi, entrochi, &c.,	241
Crustacea, or crabs, &c.,	363
Stellæ marinæ, &c.,	173
Fishes, and their parts,	1,555
Birds, and their parts, of different species,	1,172
Vipers, serpets, &c.,	521
Quadrupeds, &c.,	1,886
Insects,	5,439
Humana and calculi; anatomical preparations,	756
Vegetables, as seeds, gums, woods, roots, &c.,	12,566
Hortus siccus, or volumes of dried plants,	334
Miscellaneous things, natural, &c.,	2,098
Pictures and drawings, &c., framed,	310*
Mathematical instruments,	55

Another list of the objects of Sir Hans Sloane's Museum, is printed in the introduction to the British Museum Synopsis, for 1815, (p. 3, note,) in which it is said that the quadrupeds, and their parts, amounted to 8,186, and the stones, ores, bitumens; &c., to 9,942. This account is stated to have been made up from a schedule handed about at the time of the purchase; its authenticity, however, is not vouched for. But why not quote the contemporary account in the *Biographia Britannica*, or refer at once to the catalogue itself, for information? It was surely accessible to the person who compiled this introduction!

"Besides this mass of curiosities," continues the writer in the *Biographia Britannica*, "his library consisted of more than 50,000 volumes, (347 of which were illustrated with cuts, finely engraven, and colored from nature,) 3,566 MSS., and an infinite number of rare and curious books."†

Of the Sloanean MSS., the *Penny Cyclopedia* (art. British Museum,) furnishes the following, as we are told, *demi official* account. "This collection principally consists of MSS. on natural history, voyages, and travels, upon the arts, and especially upon medicine. It comprises the chief of the celebrated Kœmpfer's MSS., with the voluminous medical collections of Sir Theodore Mayerne, and amongst them the annals of his practice in the court of England, from 1611 to 1649. It also contains a collection of medical, and other scientific correspondence, with numerous MSS. on history, poetry, and miscellaneous subjects."

We have no objection to a demi-official account of the British Museum in the Penny, or any other Cyclopedia;* but why do not the Trustees direct a sketch of the history of the Museum to be prefixed to the Synopsis, or Guide? This was done seventeen or eighteen years ago, but has been discontinued. That this Guide is susceptible of great improvement, in other respects, was admitted by the officers themselves, when examined before the Committee of Inquiry last session. See the Natural History Evidence, passim. In pp. 60, 61, and 65, of the Synopsis published in 1835, we are informed, (*mirabile dictu*) that the flesh of the salmon furnishes "one of the greatest delicacies of the table;" that the "flesh of the cod is white, regularly separates into flakes, is easy of digestion, and very palatable;" and that "the flesh of the sturgeon is excellent!!!" As the Synopsis is now said to be out of print, we trust that something more worthy of a National Museum will be produced. The price also should be reduced one-half, at least. See Evidence, No. 2769, 2794, and Appendix, p. 444. From the catalogue of printed books, (1817,) it would appear that the Museum does not possess a complete set of its own Synopsis; it is also no less strange than true, that no authorised guide to the curiosities of the place, was published for nearly half a century after it was opened.

"It is easy to perceive," observes the writer in the *Biographia Britannica*, "the advantage that will result to the public from this immense collection. To have access to such a cabinet as this is, in effect, to men

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* Dodsley, in his Guide (1761,) enumerates some of the principal portraits, forty-six in number, of kings of England, and of numerous distinguished individuals. Some of these, we believe, are now exhibited in the Mineral Gallery, at the Museum, but the transverse light from the double horizontal skylights, renders it extremely difficult to choose any position from which they may be seen with advantage. Why are not these portraits transferred to the National Gallery, where Sir George Beaumont's, and the Rev. Holwell Carr's pictures, bequeathed to the Museum, are very properly placed?

† It must always be a matter of regret, that any of Sir Hans's books should have been *sold*. A considerable number, it is said, were "turned out" as duplicates, only a few years since. These were the founder's books, and should never have been disposed of; but many belonging to the Royal Library of the kings of England, given by king George II., have shared the same fate.

* See *Mechanics' Magazine*, May 23, 1836, vol. xxiv. p. 39.

of taste, like *making the tour of the world*, and having for their tutor a catalogue of thirty-eight volumes in folio, and eight in quarto, containing a short description of each curiosity, with a reference to the authors that treat of it more at large."

"From the British Chronologist," (vol. iii. p. 130, col. 2,) we learn that when the will of Sir Hans Sloane was proved, "Administration was granted to the Lord Cadogan, and Dr. Sloane Elsmere, Rector of Chelsea. The will consisted of five sheets of paper, all written with his own hand; and there were nine codicils to it. The testator, desirous that his collection *might be kept entire*, directed it to be offered to his Majesty at 20,000*l.*; and if this offer was declined, then first to the Academy of Sciences at St. Petersburgh, and then successively to the Royal Academy of Sciences at Paris, Berlin, and Madrid. If the King and Parliament accepted the offer, Sir Hans' trustees* were to apply for a power to enable them to preserve, maintain, and continue the collection at Chelsea, where it was to be shown, under proper regulations, for the satisfaction of the curious, and the improvement of knowledge." In the second codicil, Sir Hans observes, "Having had from my youth a strong inclination for the study of plants, and all other productions of nature, and having, through the course of many years, with great labor and expense, gathered together whatever could be procured, either in our own or foreign countries, that was rare and curious, and being fully convinced that nothing tends more to raise our ideas of the power, wisdom, goodness, providence, and other perfections of the Deity, or more to the comfort and well-being of his creatures, than the enlargement of our knowledge of the works of nature, I do will and desire, that for the promoting of these noble ends, the glory of God, and the good of man, my collection, in all its branches, may be, if possible, *kept and preserved together, whole and entire*, in my manor-house at Chelsea, &c." Sir Hans afterwards appoints several persons as a Board of Visitors, "to visit, correct, and reform, from time to time, as there may be occasion, either jointly with the said trustees, or separately, &c.;" and had this valuable regulation been attended to by the Legislature, in framing the act of incorporation for the British Museum, there would, probably, have been but little necessity for a Parliamentary inquiry.

From the respectable authority already quoted, we extract the following interesting account of the proceedings, which took place after the death of Sir Hans:

"1753—Jan. 27. The Lord Cadogan, and the other executors of the late Sir Hans Sloane, Bart., having desired the trustees who were appointed by Sir Hans, *to take care and keep together his Museum*, to meet at the Manor-house at Chelsea, at ten in the morning, they met there, accordingly, about forty. Lord Cadogan was there, and received them in the politest manner; and having caused the galleries, libraries, and all the other apartments, to be shown, they assembled in the great room, where his Lordship produced Sir Hans' will, and acquainted the trustees with the codicils, the nature of which has been already detailed. In case the offer was excepted, as to the Museum remaining at Chelsea, he gave the Manor-house there,* with the Mvseum, as it is now disposed, which would save the expense and hazard of removing the same; to be kept open, at proper hours, for the access of the studious and curious. Then Mr. Sloane acquainted the trustees that the executors being apprehensive of danger, *the medals, of which there were great quantities of gold and silver, besides a series of curious copper ones, and the precious stones, such as pearls, rubies, emeralds, &c., and the vases of gems, &c.*, had been removed for safety to the Bank of England, and that two of the executors had seen them all packed up. The Earl of Macclesfield having been desired by the trustees to take the chair, the will and codicils were read. Lieutenant General Oglethorpe† gave an account of the intention of Sir Hans, of the nature and val-

* These were 58 in number, containing the names of some of the most distinguished persons, scholars, and philosophers, of the day, both English and foreign. Among the foreigners who are trustees, are, it is curious to remark, the names of the Right Hon. Henry XXVIII. Count of Reuss; the Rt. Hon. and Rev. Count Zinzendorf, the Lord Advocate, and of the Chancellor and Agent of the United Fratrum, a sect founded by Count Zinzendorf, and afterwards known by the appellation of "Moravians." Vide British Chronologist, vol. iii. pp. 136, 137.

* Sir Hans' trustees having afterwards consented to the removal of the Museum from Chelsea, the government gave them the Manor-house, to be disposed of, along with his other property, for the benefit of the family.—*Biographia Britannica*, art. Sloane.

† This gentleman, with Archbishop Potter, patronised Count Zinzendorf, and obtained an act of Parliament for the protection of his followers throughout the British dominions.

ue of the Museum, and produced an abstract of the articles it contained,* and desired that Mr. James Empson, who had taken care of the Museum for many years past, by Sir Hans Sloane's order, should read the abstract and explain the articles, which he did accordingly, and was appointed their Secretary by the Trustees. Sir George Littleton then moved, and Mr. West seconded, that a memorial should be presented to his Majesty, relating to this matter, and a committee was appointed to draw up the memorial, and lay the same before a general meeting of the Trustees." This having been done, on June 7, 1753, an act of Parliament was passed for purchasing Sir Hans Sloane's Museum, and also the Harleian collection of MSS., and for providing a general repository for the same, as also for the Cottonian Library, by a lottery. This is the act of incorporation of the British Museum, that body not having yet obtained any charter. Montague House was afterwards purchased by the government for 10,000*l.*; and the various collections having been removed to this depository, the British Museum was opened for public inspection on the 15th of January, 1759.

Among the *first elected* Trustees appointed to conduct the new establishment, were several persons eminent for learning and science; viz., the Right Honorable Philip York, author of the justly celebrated "Athenian Letters;" Sir George Lyttleton, Bart., afterwards Lord Lyttleton, the well-known author; Sir John Evelyn, Bart., son of the celebrated Sir John Evelyn, and himself an author; Nicholas Hardinge, Esq., a Barrister, author of Latin Poems, and distinguished for the cultivation of the Belles Lettres; the Rev. Dr. Birch, Secretary of the Royal Society, and author of many well-known biographical and historical works; Dr. John Ward, Professor of Rhetoric at Gresham College; and Mr. William Watson, afterwards Sir William Watson, a celebrated physician of the day.†

The *Biographia Brittanica* (art. Sloane,) presents us with a curious account of the first establishment of *officers*, which consisted of a Principal Librarian‡ at 200*l.* a-year; three Under Librarians, 100*l.*; three Assistants, 50*l.*; a Keeper of the Reading-room, 50*l.*; a Porter and Messenger, 50*l.*; one man, 30*l.*; and four women servants; which would probably amount to 900*l.* a-year, and notwithstanding the insignificance of their pay, "the officers were remarkable for being a sensible and learned set of men;"* the salaries of the officers, assistants, attendants, &c. in 1835, was more than *eleven thousand pounds*:† between the years 1823 and 1835, 393,600*l.* has been spent on the new buildings; and the other grants by Parliament, from the year 3751 to 1835, amount to 619,661*l.*!‡ These facts being upon record, we cannot see with what justice the secretary of the Museum can complain of "*the necessity of perpetual reference to the House of Commons; of the jealousy of that House in regard to the mode in which the public money is expended, the clamor more or less prevalent for economy, furnishing sometimes a reason for declining expense,* AND ALWAYS A CONVENIENT EXCUSE, *as obstacles to the improvement of the British Museum; and as tending to prevent that course of* DIGNIFIED LIBERALITY *which is best calculated to secure the respect and affection of the people, and to promote their wealth and happiness.*"§ Admitting that this censure applies to past governments, the present executive must be exempted from any such caustic observations. In August, 1835, in addition to the sums above stated, the British Museum received a special grant of 6000*l.* for the purchase of Mr. Salt's Egyptian Antiquities; and in the present year they have been enabled to obtain, by the liberality of the Treasury, without applying to Parliament, Mr. Sheepshanks's magnificent collection of Dutch etchings, which cost 5000*l.*; a portion of

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* Already given in p. 260.

† Universal Magazine, for December, 1753, vol. xiii. p. 283.

‡ It is a curious fact, that the three first persons who held this office were *physicians*, viz., Dr. Knight, Dr. Maty, and Dr. Moxton. Joseph Planta, Esq., F.R.S., succeeded the latter in 1799, and for twenty-eight years discharged the responsible duties of his office in a manner which excited the admiration, and gained for him the esteem, of every one who had occasion to seek his assistance. His uniform courtesy of manners and gentlemanly deportment, as well as his proficiency in modern languages—which enabled him to pay proper attention to the many distinguished foreigners who visited the Museum—must be fresh in the recollection of many of our readers. Mr. Planta was at once "a scholar and a gentleman." *Heu valde deflendus!*

* Dodsley, Introduction, p. 6.

† 11,082*l.* 8*s.*; the whole expenditure being 19,076*l.* 4*s.*—Vide Annual Parliamentary Account for 1835, presented in 1836.

‡ British Museum Report, 1835. Appendix, p. 568.

§ Ibid. Evidence, No. 623.

Mr. Heber's MSS. of the value of 2000*l.*; the celebrated collection of Durand vases, said to be greatly superior to the Hamilton collection, the price of which has not yet transpired; and lastly, unique Bible of Alcuin and Charlemagne, which was bought in at Mr. Evans's for 1500*l.*, but which has since been purchased by the Museum for a less sum.

After this, let us hear no more of the "obstacles to the improvement of the British Museum;" the only real "obstacle" to its improvement, and to the consequent extension of its public utility, is to be found in the *defective constitution* of that establishment, so pertinaciously defended by two of its leading officers.* Let us hope, however, that when the present Committee of Inquiry make their Report to the House, some plan may in consequence be adopted which will effect the desired result.

We cannot conclude this brief history of the foundation of the British Museum, without expressing our surprise and regret, that the British public, or rather those by whom the people are represented, should be so indifferent to the memory of Sir Hans Sloane as not even to exhibit a memorial of this illustrious man in any part of the Museum visited by the public. On entering the hall of this establishment, where it would naturally be expected that some such memorial should be found, we seek in vain for any "storied urn" or "animated *bust*" that shall remind us of the magnificent bequest of one of the greatest men of his day. But what are the objects presented to our view? A statue of Shakespeare, by Roubilliac; another of Sir Joseph Banks,† a very different person from the immortal bard of Avon; a guilt figure of Gaudma, a Burmese idol; and the statue of the Hon. Anne Seymour Damer, (who gave a Napoleon snuff-box to the Museum,) holding in her arms a pretty little naked baby, said to represent the "Genius of the Thames." All this incongruous array doubtless puzzles many of the simple folk who visit the Museum, and we have occasionally overheard many learned discussions as to which of these august personages the honour of founding the Museum belongs. It may be said, perhaps, by the Trustees that Sir Hans' "Collections" are the best statue that could be erected to his memory—*si monumentum requiris, circumspice!* but suppose that it should turn out that a *bust* of Sir Hans Sloane was formerly in the possession of the Museum, will it be considered *crimen læsæ majestatis* to inquire what has become of it? Is it placed in the Medal Room,* together with the busts of Sir Thomas More, Dr. Samuel Clarke, and a noble bust of Homer, in bronze, of the most exquisite Greek sculpture, said to have been found near Constantinople?† And, like the coins, medals, and gems,‡ and certain MSS., are these "busts" become "select," and to be inspected only by "particular permission," and "by a few persons at a time?" Or has the bust of Sir Hans been consigned to the obscurity of some attic? Or has old *Tempus edax rerum* crumbled this frail memorial into its original dust? Arise, shade of Sir Hans! and haunt the nightly slumbers of the Curators till "the bust" be restored to its "pedestal on the staircase,"§ where, in the year 1784, it was still to be seen, but where the "musk-ox" now presents itself to our gaze.

Although no notice can be found of Sir Hans Sloane's bust, or of those just enumerated, in the "Museum Synopsis" of 1835, *another bust* is named with the most elaborate praise—that of Mr. Charles Townley, whose collections were purchased by the Government, after Committees of the House of Commons had been appointed to ascertain their commercial value; and although it may be quite proper to preserve *his* bust, it should not supersede that of the founder of the Museum. There is also in the Print Room a portrait of Sir William Hamilton, whose collection was purchased. We seek in vain, however, for any memorial of Sir Hans Sloane; his name occasionally figures in the "Synopsis," but only in

* See the Evidence of Sir Henry Ellis and Mr. Forshall, passim.

† There is also a *portrait* of Sir Joseph Banks, by Lawrence, in the Cracherode Room.

* "A few modern busts, some of which belonged to Mr. R. P. Knight, are preserved in the Medal Room."—Penny Cyclopedia, art. British Museum. And it may be added, a bust of some unknown female in the Magna Charta Room; of this presiding *deesse* we know nothing.

† Dodsley's General Contents of the British Museum, 8vo. 1761, p. 4 and Companion to the Principal Places in London and Westminster, 12mo. 1784, p. 94. The bronze bust of Homer is also noticed in Harris's Curiosities of London and Westminster for 1805, p. 175, but there is no mention of the bust of Sir Hans Sloane.

‡ When the Museum was first opened, the Pontifical medals were exhibited in glass cases; and in the year 1784, a series of French medals, beginning with those of Pharamond. See Dodsley, p. 18: Companion, p. 100.

§ Companion to Lond. and Westm. 1784.

company with other donors. This ought to be remedied forthwith; for we are old-fashioned enough to think with Herodotus, that "*Things past ought not to be extinguished by length of time, nor great and admirable actions remain destitute of glory.*"

S. S.

From the London Mechanics' Magazine.

EFFECTIVE POWER OF LOCOMOTIVE ENGINES ON LEVELS AND INCLINED PLANES.

Question put to Mr. Robert Stephenson, C. E., by the Committee on the London and Brighton Railway; and Mr. Stephenson's Answer.

QUESTION.

Supposing that for a long distance there is a certain strain which may be represented by any figure or letter, and that that is broken on another line by a series of ascents and descents; supposing that the total amount of strain in both instances be the same, what is the difference of effect upon the engine?

ANSWER.

In order that the following answer may be fully comprehended, it is necessary to premise, that by the terms of the question, it would appear that it is meant to determine the difference of effect of locomotive power upon two series of planes, from a point A to a point B. In the one the strain is constant, and may be represented by $\frac{1}{a}$, whilst the other is varied by ascents and descents, but so that the total expenditure of mechanical power is the same; hence it is evident that the ascents upon the latter must be more abrupt than on the former, or else they would not compensate for the descents.

Assuming these data, there cannot be a question that the lesser and more uniform strain is best adapted to locomotive power, both as regards speed and load, for the following reasons:—

1st. As regards speed. It is evident that, to render this comparison perfectly fair, it is only necessary to assume two engines of equal power and load to start simultaneously from A to B, and then assuming that on every part of each line the engine to be capable of exerting its whole power, that is, both on the ascents and descents of the undulating line, while she proceeds uniformly on the other line. On this assumption, as equal power will be so exerted in equal times by each engine, and as the total expenditure between A and B is the same, they would then both arrive at B together.

But in the case of the undulating line, this hypothesis cannot hold, except within certain limitations, for it is manifest that in practice a variety of circumstances limit the speed at which an engine can be allowed to travel, both as regards safety, wear and tear of machinery, and also the arrangement, especially of the slides for the admission of steam to the cylinders.

For these and other reasons, a speed of 35 or 40 miles per hour is as much as can be travelled safely, especially on descending planes, in the present state of our experience; hence, in order to compensate for the slowness of ascending speed, the accelerated velocity may be far beyond that which can be permitted with prudence; hence the difference of time consumed on the descending planes by the regulated velocity, and the extreme accelerated velocity is lost on the undulating principle.

For instance, between London and Brighton, by Sir John Rennie's and Mr. Stephenson's proposed lines of railway, the respective distances from London Bridge to Sir John Rennie's terminus at Brighton is 49 miles, 68 chains; and from Nine Elms to the back of Brunswick-terrace, by Mr. Stephenson's line of railway, is 54 miles, 68 chains; and going and coming the respective distances, therefore, are 99 miles, 56 chains, and 109 miles, 56 chains.

There are on Sir John Rennie's line, as described by Dr. Lardner, 32 miles of gradients to be characterised by $\frac{1}{270}$.

On Mr. Stephenson's, 28 miles by $\frac{1}{330}$.

Now assuming an engine to start on each line of an equal power and with the same load, with which load on the level it can travel at a speed of 40 miles an hour, using its whole power, then assuming the friction to be 9 lbs. per ton, or $\frac{1}{250}$, and that its whole power is consumed, the distance to and from Brighton will be travelled on each at a speed of 40 miles per hour, and the respective times will be 2. 29. 30. and 2. 44. 30. without adding for delay on the Croydon inclined plane.

But this assumes that on Sir John Rennie's descending planes the engine to travel 720 miles per hour. Whereas we will suppose them limited on each to 40 miles per hour; hence in going and coming there will be 32 miles of descending planes, the time to be added will be the difference between travelling 32 miles, at 720 miles per hour, and at 40 miles per hour, that is, of 45 minutes, 20 seconds, making the total 3. 14. 50. by Sir John Rennie's line; whilst on Mr. Stephenson's the time to be added is the difference between travelling 28 miles at 16 miles per hour, and at 40 miles per hour, that is, of 31 minutes, 30 seconds, making the total time 3 hours, 16 minutes.

To this must be added the time consumed in stoppages, that is, on Stephenson's $2+3$ minutes, being once at the Southampton Junction, and once for water. On Sir John Rennie's, $3+3=9$ minutes, being once at Greenwich Junction, once Croydon at the station, and once for water; besides delay on Croydon incline, for which 5 minutes will be a very moderate allowance.

Thus by Rennie's line . . .	3	14	50
Extra stoppages .		14	0
	3	28	50
By Stephenson's	3	16	0
Extra stoppages		6	0
	3	22	0

The difference being 6 minutes, 50 seconds, in favor of Stephenson's line. This is abstracted from the curves; now, Dr. Lardner admits that the total curvature

On Rennie's is measured by 840 deg.
And on Stephenson's, by 790 do.
Or, reduced to curves of a mile,
Rennie's . . 7 miles, $\frac{3}{3}$ of a mile radius.
Stephenson's 6 $\frac{8}{10}$ ditto.

22

Thus the total length of the respective journeys —

On Rennie's	3	36	30
On Stephenson's	3	29	0

But it may be well here to remark, that Dr. Lardner is in error as regard the curvature on both Stephenson's and Rennie's line; as the curvature

On Rennie's is . . . 15 m., 1 m. radius,
And on Stephenson's $11\frac{1}{2}$

which would make the time a little more favorable to Stephenson's line of railway.

Now, it may be observed, that the foregoing calculations are altogether independent of a difference of opinion as regards proportion of power of engines to what they are ordinarily called upon to exert or of their varying power at different speeds, because this is equally applicable to each line; but rest upon clear mechanical principles, independent of all hypothesis.

Next, if the comparison be as regards load, then the thing is very simple; for the load is either measured by the adhesion of the wheels, or else by the pressure of steam in the cylinder; in either case, the engine being identifical in power and weight, the maximum load is measured by the friction on a level plus gravity; hence the uniform or more easy gradients have a clear advantage.

Thus, between Sir John Rennie's and Mr. Stephenson's lines, the proportions are as

$$15 . 80 = 9 \times 6 + 80 = \left(\tfrac{2\,2\,4\,0}{3\,3\,0}\right)$$
$$\text{to } 17 . 50 = 9 \times 8 + 50 = \left(\tfrac{2\,2\,4\,0}{2\,6\,4}\right)$$

That is, a difference of 11 per cent. in favor of Mr. Stephenson's line in gross load; but the effective load has a different proportion still more favorable to Mr. Stephenson's line, as Mr. Rastrick admitted in his evidence, a difference of 14 per cent. in favor of the western line, but which may under various considerations amount to 20, or even a higher per centage.

It has been discovered that some of the Indian timber is singularly durable. The wood called the *jarrool* has the property of resisting the marine worms which commonly attack ships where they are not defended by copper. On a recent occasion they were found to have fastened on every description of wood forming the bottom of an unsheathed vessel save the jarrool, not even sparing the teak. The day is consequently not distant when jarrool will make a more important article of commerce than it hitherto has been.—(Observer.)

From the Journal of the Franklin Institute.

COMMUNICATION OF A FORMULA FOR FACILITATING THE REDUCTION OF OBSERVATIONS OF THE SOLAR ECLIPSE OF MAY 15TH, 1836.

BY S. C. WALKER.

TO THE COMMITTEE ON PUBLICATIONS.

GENTLEMEN: The formulæ communicated by me in the April number of the Journal, were intended for announcing the time of the principal phases of the solar eclipse of May 15. By applying a direction derived from observations made under a known meridian, hey may be used for determining the longitude of places at which it was observed, when not too far distant from Philadelphia, for which place alone, they are strictly correct. The error of the middle time of the eclipse, as deduced from the formula, amounts of one second of time for New-York and Albany, to two seconds for Baltimore and Washington, and to eight seconds for Boston and the University of Virginia. By applying to the middle time by the formula, a correction depending upon the first and second powers of the difference of longitude from Philadelphia, results may be obtained, in which the greatest variation from a rigorous computation for the above places, will in no instance exceed 0. 6 sec., and in which the average discrepancy will not exceed 0. 4 sec. In the former communication it was omitted to mention that *l*, denotes the *geocentric* latitude of the place for which the computation is made.

Retaining the same notation and constants as before, we have for the resulting longitude for the place of observation from Greenwich, +East—West

$$\lambda = A + B + C$$

Where,

$$A = \lambda' + x + \left\{ M - M' \right\} - [8.8557] \left\{ D - D' \right\}$$

$$B = [4.9781] \left\{ 5\text{h. } 0\text{m. } 40\text{s.} + A \right\}^2 - [7.1701] \left\{ 5\text{h. } 0\text{m. } 40\text{s.} + A \right\}$$

$$C = -\tfrac{1}{5} \left\{ {}'A + B - \lambda' \right\}$$

In these equations

λ' = Assumed longitude from Greenwich, in seconds of time.
M = Local mean time of middle, observed,
M' = do. computed by formula.
D = Duration, observed.
D' = do. computed,
x = A correction for the errors of the tables.

The unknown quantity x, is the mean of the times at beginning and end, in which the moon by its apparent motion, traverses a space equal to the tabular error on its true orbit, projected upon its apparent orbit.—No material error will arise from assuming x, as constant for the limits to which this formula extends. Of the extent to which it may be used, an opinion may be formed from the following table, in which the middle time $M' + B$ derived from it, is compared with the rigorous computations for several places in the American Almanac.

Place.	M′	B.	Middle by Formula M′ + B	Middle by Am. Almanac.	Difference.
Philadelphia,	8 17 55.35	+0.00	8 17 55.35	8 17 54.75	+0.60 s.
Boston,	8 42 30.80	+7.73	8 42 38.53	8 42 38.90	—0.37
Providence,	8 39 42.55	+6.31	8 39 48.86	8 39 48.65	+0.21
Albany,	8 30 11.15	+0.60	8 30 11.75	8 30 11.80	—0.05
New-York,	8 25 1.45	+0.32	8 25 1.77	8 25 1.65	+0.12
Baltimore,	8 9 40.95	+1.69	8 9 42.64	8 9 43.20	—0.56
Washington,	8 6 58.30	+2.56	8 7 0.86	8 7 0.30	+0.56
University of Virginia.	7 58 10.33	+7.37	7 58 17.70	7 58 18.15	—0.45
					8)2.92
Greatest difference, 0. 6 sec.					Mean difference, 0. 36 s.

The determination of x, requires observations under known meridians. This eclipse having been visible at European observatories, the value of x, will admit of accurate computation. If we assume the longitude of independence Hall, Philaddlphia, at 5h. 0m. 40s. west from Greenwich, we shall have, after correcting for the small dif-

ferences of longtitude of several places of observation in Philadelphia, the following values of x,

Observations of	R. M. Patterson, M. D.	$x = -11.15$ sec.
"	T. M'Euen, M. D.	$x = -9.67$
"	W. H. C. Riggs,	$x = -11.40$
"	S. C. Walker,	$x = -11.93$
		44.15
Mean of four observations,		$x = -11.04$

Bs an application of the formula, let it be required to deduce the longitude of the Capitol at Washington, from the observations of F. R. Hassler, Esq. Latitude 38° 52′ 54.″ Beginning observed 6h. 53m. 58s. End at 9h. 20m. 8s., A. M. Mean time.

Computation of the longitude of the Capitol.	1st. Approximation.	2d. Approximation.
(1).... assumed λ'	— 5h. 8m. 7.20	— 5h. 8m. 10.02
(2).... assumed λ	— 11.04	— 11.04
M	+ 8 7 3.00	+ 8 7 3.00
M′	+ 8 6 58.30	+ 8 6 54.88
(3).... M—M′	+ 4.70	+ 8.12
D	+ 2 26 10.00	+ 2 26 10.00
D′	+ 2 26 13.60	+ 2 26 12.24
D—D′	— 3.60	— 2.24
(4).... — [8.8557] {D—D′}	+ 0.26	+ 0.20
(1)+(2)+(3)+(4).... A	— 5 8 13.28	— 5 8 12.74
5h. 0m. 40s.+A	— 7 33.28	— 7 32.74
(5) ....+ [4.9781] {5h. 0m. 40s. + A}^{2}	+	+ 1.92
(6) ....— [7.1701] {5h. 0m. 40s. + A}	+	+ 0.67
(5)+(6) .... B	+ 2.56	+ 2.59
A+B	— 5 8 10.72	— 5 8 10.15
A+B—λ'	— 3.52	— 0.13
$-\frac{1}{5}$. {A+B—λ'} =C	+ 0.70	+ 0.03
A+B+C =λ	— 5 8 10.02	— 5 8 10.12

Similar computations from John Gummere's observations, give the longitude of Haverford School.

Observed beginning	7h.	3m.	24.5s.
" end	9	31	47.
" latitude	40°	1′	12″
assumed λ''	5h.	1m.	26.8s.
First approximation λ'	5	1	16·94
2d " λ	5	1	16.15

From the Journal of the Franklin Institute.

OBSERVATIONS OF THE SOLAR ECLIPSE OF MAY 15TH, 1836. COMMUNICATED BY DIRECTION OF THE AMERICAN PHILOSOPHICAL SOCIETY.

TO THE COMMITTEE ON PUBLICATIONS.

GENTLEMEN:—By direction of the American Philosophical Society, I send you an abstract of the observations of the late solar eclipse, which have been communicated to the Society. It is not complete, some particulars being required which will probably be obtained from the observers, by the committee to whom the observations have been referred, to prepare them for publication in the Society's transactions.

The times of beginning and end are in mean time of the places of observation.

Very respectfully yours,

A. D. BACHE,

One of the Secretaries, Amer. Philos. Soc.

Table of observations of the beginning and end of the solar ecliepse of May 15th, 1836, as observed at Philadelphia, &c.

Places of Observation.	Time of beginning of Eclipse.	Time of end of Eclipse.	Observers' Name.	REMARKS.
Philadelphia.	h. m. s.	h. m. s.		
1. Hall of Am. Phil. Soc.	7 3 45.8	9 32 38.3	Dr. R. M. Patterson,	
2. Dr. McEuen's house.	7 3 38.0	9 32 38.1	Dr. T. McEuen,	2770 feet west of Philos. Hall.
3. "	7 3 50.0	9 32 26.5	Mr. W. H. C. Riggs,	
4. No. 100 S. 8th st.	7 3 40.9	9 32 44.1	Mr. S. C. Walker,	1340 feet west of
5. No. 231 Market st.	7 3 41.0	*9 32 34.0	Mr. Sellers,	Philos. Hall. Teles. 42 inches achrom.
Haverford school,†	7 3 24.5	9 31 4.07	Mr. Jno. Gummere,	Telescope 42 inch. achrom.
Germantown, Pa.	7 3 54.5	9 32 44.5	Mr. Isa. Lukens,	
	7 3 55.5	9 32 49.5	Mr. C. Wistar,	Telescope 3 feet achrom.
Phœnixville, Ches. co.‡	7 3 12.0		Mr. H. Wilson,	
West Hills, L. I.§	7 12 48.5	9 43 40.0	Mr. J. Ferguson,	Large repeating circle of coast survey, used for observations.
Washington City,	6 53 58.0	9 20 08.0	Mr. F. R. Hassler,	

* Doubtful.

† Assumed lat. 40° 01′ 12″. Long. 5h.01m. 25s.

‡ Assumed lat. 40° 08′ 07″ Long. deduced by H. Wilson, from eclipse, 5h. 01m. 57s.

§ One of the station points of the coast survey. Lat. 40° 48′ 49.2″. Long. 73° 26′ 12″.

From the Journal of the Franklin Institute.

COMMITTEE ON SCIENCE AND THE ARTS. REPORT ON MR. AMASA HOLCOMB'S REFLECTING TELESCOPE.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, to whom was referred for examination, a Reflecting Telescope, invented by Mr. Amasa Holcomb, Southwick, Massachusetts, REPORT:—

That the following description of the instrument, submitted to the Committee, is given by Mr. Holcomb, viz:

"It is of the reflecting kind, having the front view, and has a focal length of about nine and a half feet, and an aperture of eight and a half inches. It has six eye pieces, of powers from ninety to nine hundred and sixty."

The evenings of the 22d and 23d of April, proving unfavorable, a third trial was made on the following night, when the performance of the instrument was very satisfactory. It is of the same size as the largest submitted last year. The mechanical execution of the mounting is quite superior, and leaves little to be desired, whether we regard steadiness, convenience in command of the instrument, or facility of finding objects.

The committee do not hesitate to pronounce this instrument superior in performance to any that have yet been exhibited by Mr. Holcomb.

The ring of Saturn was seen to be double by all the members of the committee present, the dark space between the rings could be observed on each ansa, half way to the conjugate axis of the perspective ellipse, under which it was viewed.

ζ Bootis which last year was so far separated that the discs became tangent to each other, presented the same appearance this year, with a power of 250. But with a power of 960 the dark space between the stars was equal to one-fourth of the disc of either.

In ζ Cancri, the close pair, distant about 1″.1, were so far separated that the dark space was visible as a line between them. This was considered too difficult for either of the telescopes exhibited last year.

A power of 960 was used in examining γ Virginis. This remarkable pair, of which

the distance is 0″.8, according to Herschel's ephemeris, or 0″.6, according to Struve's late measurements, give no indications of being double.

This instrument was made to order for John A. Fulton, Esq. of Chillicothe, Ohio, a gentleman whose liberal encouragement of this department of the arts is worthy of all commendation. While, however, the committee would applaud the patriotism of those individuals, or corporate bodies, who encourage American artists, they cannot but remark, that should the course of Mr. Holcomb be suddenly arrested, and the manufacture of these instruments cease in this country, their place could hardly be supplied by importation, at three times their present cost.

The four or five choice instruments made by Mr. Holcomb, have been the result of twice as many years of labor and perseverence, for which no adequate compensation can have been expected, except that satisfaction which every lover of science feels, in improving and extending the means by which it may be pursued.

The committee have little doubt that under proper auspices, and at an expense not exceeding that already encountered by some of our corporate institutions, in procuring instruments of little use, a twenty foot telescope might be made, which should do honor at once to the artist and the country.

By order of the committee.

WILLIAM HAMILTON, *Actuary.*

March 11, 1836.

From the Journal of the Franklin Institute.

REPORT OF THOS. JEFFERSON CRAM, PRINCIPAL ASSIST. PROF. NAT. AND EXP. PHILOS. U. S. MIL. ACADEMY, UPON EXPERIMENTS RELATIVE TO THE STRENGTH OF CAST-IRON BEAMS.—[COMMUNICATED BY PROF. A. D. BACHE.]

1. Soon after the destructive conflagration which devoured a large and valuable portion of the City of New-York, last winter, as a very natural consequence, the attention of capitalists became more fully awakened to the importance of constructing fire-proof buildings. Accordingly a demand was made upon Gov. Kemble, Esq., Principal of the West Point Foundry, for estimates of the cost of furnishing cast-iron, to replace the combustible parts which had hitherto been used in the interior of store houses and shops. To answer fully the demand which had been made upon him, Mr. Kemble thought it expedient to make a careful series of experiments upon the relative strengths of cast iron beams of various forms, in order to ascertain, beyond a doubt, those which would be convenient for the particular object in view, and which would, at the same time, afford the greatest strength with the least cost. Through the politeness of Mr. Kemble, I had an opportunity of being present at the time of subjecting his cast-iron beams to the test of experiment; and believing that the results of those experiments will prove highly useful to the cause of construction in genera', the writer of this begs leave to make them public through the medium of the Journal of the Franklin Institute.

2. It is presumed that the accompanying drawings will enable the reader to understand the forms of the experimental beams, it being remarked, that, in each case, the form was such as would be generated by giving the figure representing the cross section, a motion of translation only, along a straight line—keeping the moving area constantly perpendicular to the line of motion. The lower rectangle, *e*, *e*, *f*, *f*, would thus generate the "lower rib," and the upper rectangle, *a*, *a*, *b*, *b*, would generate the "upper rib," of the beam; and the rectangle, *c*, *d*, *d*, *c*, would generate what we shall call the vertical plate of the beam. It will be seen at once, that almost any distribution of a given quantity of material, may be effected, by merely varying the dimensions of the rectangles in constructing the pattern for the casting.

3. The arrangement, for augmenting at pleasure, the pressure upon the beam, consisted of a combination of levers—one of which being a large Roman steelyard with a scale at the extremity of the longer arm: a small weight being placed on the scale, had its effect greatly augmented by the combined multiplying effects of the levers; and this increased effect was exerted by means of a cylindrical piece of iron laid straignt across the middle of the top surface of the beam; so that the pressure acted uniformly along the transverse line of the middle of the upper surface of the beam. By this arrangement a small weight could be carefully applied to the scale of the steelyard without exerting a percussive effect.

4. In every case, the beam was supported by resting each of its extremities upon a well squared piece of iron about two

inches in diameter, so that before exerting any pressure upon the beam, the bearing of each extremity was about two inches; and it may be well to remark here, that, immediately after the beam felt the pressure, the extremities bore only upon the inner edges of the supporting pieces of iron; and hence, the "distance between the points of support" in what follows, must be regarded as the perpendicular distance between the inner surfaces of said supporting pieces of iron.

5. The pressures exerted are expressed in English pounds avoirdupois; the linear dimensions are expressed in English inches and parts, and the superficies in square inches. The dimensions were measured several times and when any difference was found, a mean of the whole was taken as the final result. The drawings are all made upon a uniform scale, the top and the front views containing, of course, but a small portion of the beam in length. The depressions recorded in the tables, were measured with the utmost care.

6. EXPERIMENT I.

Fig. 2. *Fig.* 4. *Fig.* 3. *Fig.* 1.

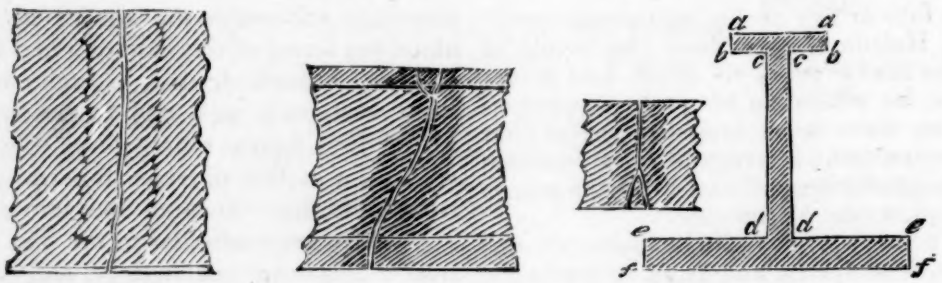

Fig. 1. represents a cross section of the beam.

Fig. 2. a top view of the fracture of the lower rib.

Fig. 3. a top view of the fracture of the upper rib.

Fig. 4. a side view of the fracture of the beam.

DIMENSIONS, &c.

Depth, *a*, *b*, of upper rib,	.31 in.
" *c*, *d*, of vertical plate,	4.15
" *e*, *f*, of lower rib,	0.66
Total of the beam,	5.12
Breadth *a*, *a*, of upper rib,	2.36 in.
Thickness *d*, *d*, of vert. plate,	0.394
Breadth *f*, *f*, of lower rib,	6.74
Area *a*, *a*, *b*, *b*, of cross section of upper rib, (in sq. in. and parts,)	0.7316
Area *c*, *d*, *d*, *c*, of cross section of vertical plate, (in sq. in. and parts,)	1.6351
Area *e*, *e*, *f*, *f*, of cross section of lower rib, (in sq. in. and parts,)	4.4484
Area total of cross section of beam,	6.8151

Total length of beam, 60 inches; distance between points of support 54 inches; and weight of the beam 105 lbs.

CIRCUMSTANCES.

The pressure being exerted upon the top of the upper rib, the upper part of the beam experienced a compression of its particles; and the lower part an extension of its particles. Augmenting the pressure by degrees—so carefully, however, as not to produce a percussive effect—the beam bent more and more as the pressure increased, until of a sudden it ruptured. The annexed table exhibits the depressions of the middle of the beam in proportion as the pressure was augmented.

Pressures upon the middle.	Depressions of the middle.
$\frac{1}{2}$ (105)= 52$\frac{1}{2}$ lbs.	0.00 in.
15676	0.28
17244	0.32
18028	0.34
19596	0.40
20380	0.42
21948	0.46
23516	0.52
25084	0.58
25868	Beam broke.

No indications of rupture were observed during the successive augmentations of the pressure, until the beam suddenly broke under the last pressure recorded in the table ; and the whole time between the applications of the first and last pressures was nearly twenty-five minutes.—The drawings faithfully exhibit the appearance of the fracture ; and it will be perceived that the fracture of the top of the beam was produced by compression, and that of the bottom, by extension. Dividing 25868 lbs., by 68151 square inches, it will be found that this beam broke under a pressure of 3796 lbs., per square inch of cross section ; and an inspection of the table will show the circumstances of its resistance to flexure. It should be remarked, that this beam was cast on its side, and therefore had less strength than if it had been cast on end.

7. EXPERIMENT II.

Fig. 6.

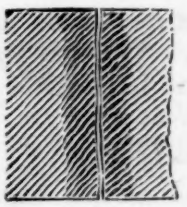

Fig. 7.

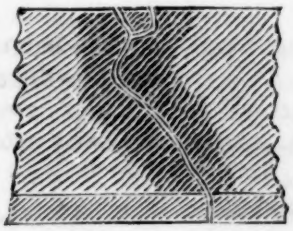

Fig. 5.

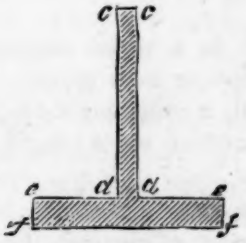

Fig. 5. represents a cross section of the beam at the place of fracture.

Fig. 6. a top view of the fracture of the lower rib.

Fig. 7. a side view of the fracture.

DIMENSIONS, &c.

No upper rib,	0.00 in.
Depth *c*, *d*, of vertical plate	5.10
" *e*, *f*, of low rib,	0.74
" total of beam,	584
Thickness *c*, *c*, of vert. plate	0.46 in.
Breadth *f*, *f*, of lower rib,	5.12
Area *c*, *c*, *d*, *d*, of cross section of vertical plate (in sq. in. and parts,)	2.346
" *e*, *e*, *f*, *f*, of cross section of lower rib, (in sq. in. and parts,)	3.7888
" total of cross section of beam, (in sq. in. and parts,)	6.1348

Total length of beam 60 inches ; distance between points of support 54 inches ; and weight of the beam 77 lbs.

CIRCUMSTANCES.

There was no upper rib to this beam ; therefore the pressure was exerted upon the top, *c*, *c*, of the vertical plate so as to compress the upper parts of the beam and to extend the lower parts. The pressures were augmented at intervals of a few minutes, and with all possible care to prevent percussion. The following table contains the pressures exerted, and the corresponding depressions, which were carefully noted.

Pressures upon the middle.	Depressions of the middle.
½ (97) = 48½ lbs.	0.00 in.
15672	0.28
16456	0.28
17240	0.32
18024	0.32
18800	0.36
19592	0.38
20376	0.40
21160	0.42
21944	0.46
22728	0.48
23512	0.54
24296	Beam broke.

No signs of a rupture appeared until all of a sudden the beam broke a few seconds after the application of the greatest pressure recorded in the table : the whole time between the applications of the first and last pressures, was about thirty minutes. The drawings show, that the fracture at the top was produced by compression, and, that at the bottom, by extension of the particles of the beam. Dividing 24296 by 6.1348, we obtain 3960 lbs., for the pressure per square inch, of cross section, which this form of beam sustained before breaking. The table shows the state of the flexure at the different periods of the operation, and the

drawings will explain the peculiarities of the fracture. This beam was cast on end; and it will be seen, that this form sustained more, before breaking, by 164 lbs., to the square inch of section, than that of Experiment I.

Fig. 9.

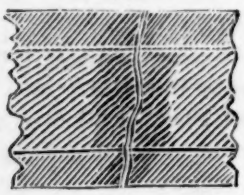

Fig. 8. is a cross section of the beam when rupture took place.

Fig. 9. a side view of the fracture.—The fractures were nearly straight across the ribs.

Depth, *a*, *b*, of upper rib,	0.800 in.
" *c*, *d*, of vertical plate,	3.12
" *e*, *f*, of lower rib,	0.80
" total of beam,	4.72
Breadth *a*, *a*, of upper rib,	2.42 in.
Thickness, *c*, *c*, of vert. plate,	0.94
Breadth, *e*, *e*, of lower rib,	2.42
Area *a*, *a*, *b*, *b*, of cross section of upper rib, (in sq. in. and parts,)	1.9390
Area, *c*, *c*, *d*, *d*, of cross section of vertical plate, (in sq. in. and parts,)	2.9328
Area, *e*, *e*, *f*, *f*, of cross section of lower rib, (in sq. in and parts,)	1.9360
Area total of cross section of beam, (in sq. in. and parts,)	6.8048

Total length of the beam 60 inches; distance between points of support 54 inches; and weight of the beam 102 lbs.

CIRCUMSTANCES.

This beam very suddenly broke under (the first pressure applied,) 15674 lbs.—Indeed, it was doubtful even whether that amount of pressure had yet been fully exerted. Admitting however, that the whole pressure was felt, the beam broke under a pressure of only 2304 lbs. per square inch of cross section; and if the whole amount of pressure was not exerted, of course the beam was still less strong. This beam was cast on its side from the cupola furnace, and with no selection of metal, but all from one ladle. The sudden rupture

8. EXPERIMENT III.

Fig. 8.

of this beam made it impossible to measure the depressions. The drawing of the fracture would seem to indicate that it broke by extension.

EXPERIMENT IV.

9. The beam tried in this experiment, was exactly of the same form and dimensions as that of experiment II.; but it was not so good a casting. It was placed with the rib uppermost, in a manner exactly reverse of that described in experiment II., so that the pressure was exerted upon the top surface of the rib, the beam resting with the edge of the vertical plate upon the supports; and thus causing a greater portion to experience compression, and a less portion to experience extension, than in either of the other experiments. Under these circumstances, the beam ruptured very suddenly even before the pressure arising from the apparatus of levers alone, had been brought to act fully upon the rib; thus affording a striking example of the great gain of strength, by giving a proper position to the beam with respect to the manner in which its different parts are to be strained—whether by compressing or by extending its particles.

10. Representing by 1.00 the strength of beam in experiment I., per sq. inch of cross section, the relative strengths of the different forms to resist rupture, will be expressed as follows:

Beam of the form described in Exp. I., Strength to resist rupture,	1.00
Beam of the form described in Exp. II., Strength to resist rupture,	1.04
Beam of the form described in Exp. III., Strength to resist rupture,	0.44

By comparing the areas of the cross sections of the different forms, it will be

seen that greater strength may be gained, at a less expense of metal, by giving the beam the form in experiments I and II., instead of the form in experiment III.

All of which is respectfully submitted.

THO. JEFFERSON CRAM.

To Prof. A. D. BACHE, Univ. of Penn.

West Point, June 1836.

From the Journal of the Franklin Institute.

REPORT ON MESSRS. GARRETT AND EASTWICK'S LOCOMOTIVE STEAM ENGINES.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, to whom was referred for examination, the Locomotive Engines made by Messrs. Garrett and Eastwick, report :—

That they have examined one of these engines now in progress of construction, at the shop of Messrs. Garrett and Eastwick, and witnessed the performance of another which has been completed and placed on the Philadelphia and Trenton Railroad for trial.

They are constructed upon the principle of outside connections, the general arangement being similar to that adopted by Mr. M. W. Baldwin, with some modifications, however, of sufficient importance to give them a distinct and original character.— The most striking peculiarity is in the manner of reversing. This operation is performed in the different engines heretofore in use, by various contrivances, all of which involve the necessity of ungearing the connection of the eccentric rods with the rock shafts : consequently their action depends upon the contingency of throwing these parts again into gear, which can be effected only at particular points in the revolution of the eccentrics.

In the engines under considerrtion, the reversing is performed by means of moveable valve seats, which are placed between the slides and the true seats, and connected with hand levlers by rods passing through stuffing boxes in the steam chest.

In each moveable seat are five passages, four of which are steam ways and one for the exhaust ; two of the steam ways and the exhaust opening pass directly through the seat, the other two steam ways pass only about one-third through, and communicate with chambers which form oblique passages from one end of the seat to the other, so that the steam which enters the upper opening at one end of the seat, escapes by the lower opening at the opposite end.

When the moveable seat is so adjusted that the direct passages coincide with the openings in the true seat, the action of the valve is similar to the common short slide ; but if the seat be shifted, so that the communication shall be through the oblique passages, the course of the steam to the cylinder will be reversed without any change in the motion of the slide. This arrangement possesses the merit of simplicity in a high degree, and as its action does not depend upon any contingency, the engine can be reversed with certainty and precision. A small loss of steam results from the increased thickness of the valve seat, but it is believed the amount will not be sufficient to produce any appreciable effect upon the power of the engine. It has been suggested that the inequality of wear to which the movable seat will be subjected in its different positions, must render its surface irregular, and impair the tightness of the valve ; some inconvenience may arise from this source, the extent of which can be determined only be experience ; it is not apprehended, however, that the evil will be of a serious nature.

The situation of the cyli nders and driving wheels in engines, with outside connections, allows a leverage to the working strain which very much insrease the wear between the driving axles and their boxes, and also twists the frame out of its proper form. Messrs. Garrett and Eastwick have endeavored to guard against the injury resulting from this cause by some slight changes in the parts most exposed to its effects.

Instead of turning down the bearings of the driving axle to obtain a shoulder for preventing lateral motion in the axle, they leave the axle its full size throughout, and provide against lateral motion by facing the hubs of the wheels, so as to form shoulders which bear against the outer ends of the boxes. The increased extent of bearing surface which is thus obtained both within the boxes and at their ends, enables them to resist more effectually, the thrust of the engine and adds to their durability.

The firmness of the whole machine has been increased by bracing the cylinders to the fire box, and bolting to the under side of the frame a strong plate of iron, which passes entirely around it and is secured to the pull bar.

The Committee have been informed that the engine which is upon the Trenton Road, has given entire satisfaction during a trial of several weeks constant service ; the exhibition of its performance witnessed by them was highly gratifying, and they feel themselves warranted in saying that these engines afford evidence of ability to manufacture locomotives equal to any in the country for excellence of workmanship and general finish.

By order of the Committee.

WILLIAM HAMILTON, Actuary.

July 14, 1836.

From the Journal of the Franklin Institute.

REPORT OF MR. RAUB'S STEAM GAUGE.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, to whom was referred for examination, Mr. Raub's Steam Gauge, Report :—

That Mr. Raub's Steam Gauge consists of a safety valve or piston, differing in no essential feature from ordinary safety valves except that there is connected with it, by means of a lever, a weight, suspended in the water of the boiler, in such manner that when the water gets below a certain point, at which the weight is placed, the increased power of the weight, arising from its losing the support of the water, assists in opening the safety valve.

The practical effect is this :—If the safety valve is so graduated that steam will be blown off at a certain pressure, say seventy-five pounds to the inch, when the boiler is properly filled with water, it will escape at a lower pressure, say fifty or sixty lbs., to the inch, according to the dimensions of the weight, when the water is too low. In this way it is proposed to avoid the explosions, or other evil effects which might arise from a portion of the boiler becoming bare of water and heated to a higher degree.

The principle of which the weight acts, is like that of the floats which have been heretofore used, to show the height of water in the boiler, except that the weight in Mr. Raub's machine is connected with the ordinary safety valve, and the steam is blown off in large quantities when the water is too low, instead of a simple alarm being sounded.

The question for the consideration of the Committee is whether this combination, is advantageous. It is a matter of doubt, whether the blowing off of a quantity of steam when the water is deficient in the boiler, is not pernicious, as tending still more to exhaust the water ; and whether the old application of the float to regulate the supply of water is not better. Waving these questions, however, it appears evident to the Committee that if a weight or float is to be used to cause the escape of steam, when the water is too low, it is better to have it attached to a seperate valve, instead of being connected with the ordinary safety valve ; because on the latter plan it will not operate when the steam is at a low density or pressure, although the water be deficient ; and because when it does operate, the engineer cannot know whether its action is in consequence of the water being too low, or the steam too high. Hence the advantages usually anticipated from the use of floats, cannot be realized from this machine.

Whether floats or weights can safely be relied on for showing the low state of the water in the boiler, and for obviating its effects, is a question of experience which it is unnecessary here to discuss, inasmuch as Mr. Raub does not claim to have originated them, but to have made an improvement in their application : and for the reasons above stated, the Committee are not satisfied that his steam gauge, in its present form, will be found practically advantageous.

By order of the committee.

WILLIAM HAMILTON, Actuary.

May 12, 1836.

The Grand Junction Railway to unite Liverpool and Manchester with Birmingham, or at least establish a direct communication between those important marts of commerce, is proceeding rapidly. The men continue their labors night and day.—It is expected to be thrown open next summer. Fifteen of the carriages to run on it are already constructed.—[Times.]

Extract from a letter dated

AVOYLLE FERRY, ON RED RIVER. }
Sept. 8, 1836. }

D. K. MINOR:

DEAR SIR—Enclosed you will receive the Meteorological Record for the months of July and August, 1836, regularly entered as stated.

I have received of the present year one number of the Mechanics' Magazine for the month of February, and no other, until yesterday. I received the number for the month of June, Vol. 7. No. 6. whole number 42, at the same time. One for the month June, 1835, Vol. 5, No. 6, whole number 30. Making a difference in their passage of precisely one year. The Railroad Journal has been received in about the same proportion. I also received by the same mail from Washington, a number of papers, documents, &c. of different dates from January 28th, up to July 6th. From this circumstance, I hope one Post Office on the route is forwarding what they have had on hand more than twelve months back.

Most respectfully yours,
P. G. V.

P. S. *Our crops* of cotton in all this section is superior to any former crop; and owing to the continued additional improvement in extending former, and making new plantations on Red River, and tributaries, will be much larger, if the season should be favorable for picking. We have had a shower every day, for nine days past, which impedes the picking, and if they should continue long will be a disadvantage to the *crop.*

Our crop of corn has turned out generally good.

Your most ob't servant,
P. G. V.

☞In relation to the *irregularity* of the mails no one thinks of speaking now a days. The period *was* when it was not an *uncommon* thing to get letters and papers about the time when they were due, but at this time it is quite another affair. It may however be proper to say that they have *all* been forwarded.

We desire to correct a mistake into which the Troy people seem to have fallen. It was not the American Institute, but the Mechanics' Institute, which held a fair recently at Castle Garden.

The fair of the American Institute will open on the 17th proximo, when we hope to see our neighbors of Troy again in the field. From what we have heard, we expect a most brilliant affair, quite superior to that of any previous year.

AMERICAN INSTITUTE.—The American Institute held its annual Fair at Castle Garden, in New-York, last week. A large number of premiums were awarded, among which we notice one to Messrs. Leggett & Russell, of this city, for the best fur caps. Messrs. Leggett & Russell are two enterprising young gentlemen, and we are glad to learn that they have been able to bear away the prize so successfully.—[Troy paper.]

REPORT ON MR. PRUTZMAN'S LEVER LOCK AND KEY.

The Committee on Science and Arts, constituted by the Franklin Institute of the State of Pennsylvania for the promotion of the Mechanic Arts, to whom was referred for examination, the Lever Lock and Key, invented by Mr. Prutzman of Philadelphia, report:—

That they have examined the the lock and key and find it to be a specimen of both *ingenuity and workmanship.*

The main feature in the lock is the manner of securing the bolt, so as to prevent its being operated on by means of a *pick*, and to prevent a key being fitted to it unless in detached parts. The lock is arranged with tumblers working vertically, and horizontally, so as to secure the bolt in its position, when locked or unlocked. The tumblers are operated on by means of a lever inserted in the bit of the key, and working on a centre. This lever is put in motion by a plate so arranged in the lock, as to pass into one of the wards of the key, and press the lever towards the barrel or stem. One end of this lever acts on a projection raised on one of the tumblers, causing it to descend, whilst a portion of the key acts on a parallel tumbler, causing it to ascend, the opposite end of the lever acts on a horizontal tumbler, and thereby relieves the bolt. When

the bolt is shut the tumblers resume their former position and secure it in its place. A lever is placed between the two parallel tumblers and working on a centre, the bolt is secured at one end and moved by means of a key at the other, causing the bolt to move in an opposite dircction to that of the key.

The general arrangement of the lock is simple and good, and we may add the best that is within the knowledge of the Committee. From the common key an impression may be taken so as to form a duplicate, but from the present arrangement of a key, with a lever inserted, it will not be practicable, owing to the great accuracy required in the formation of the lever.

Mr. Prutzman deserves a great deal of credit for his *ingenuity*. The Committee understand that several of the locks are at present in use ; one in the banking house of the U. S. Bank, and others in the city of Baltimore. The Committee recommend it to the public, particularly to Bank directors.

By order of the Committee.

WILLIAM HAMILTON, Actuary.

May 12, 1836.

ABSORPTION OF LIGHT BY NITROUS ACID GAS.

Sir David Brewster has found that hea so modifies the absorptive power of this gas for the different colored rays, that while at ordinary temperatures it has an orange color, by raising the heat it becomes red, and finally black, not a ray of any color penetrating it. This gas produces in a spectrum formed from artificial light, dark bands analagous to those exhibited by the solar spectrum. By improving the arrangements and method of observation originally devised by Fraunhofer, of Munich, Brewster has succeeded in detecting two thousand easily recognized portions of the spectrum, separated by thin dark lines, resulting from the absorption of specific rays.

Apparent irregularities in the dark bands of the solar spectrum, were traced to the greater or less proximity of the sun to the horizon, the effect being greatest when the sun sinks below the horizon.

Sir David Brewster infers from a comparison of the lines in the solar spectrum with those produced in the spectrum from artificial light by nitrous acid gas, that the same absorptive elements which exist in the atmospheres of the sun and of the earth.

Liquid nitrous acid produces none of the fixed lines above alluded to.—[Abstract from Lond. and Edin. Philos. Mag., May.]

FACT IN THE THEORY OF VISION.—On the retina and pigment of the eye of the calamary (Sepia Loligo.) It will be recollected that an important argument in favor of that theory of vision which assigns the choroid coat and not the retina as the seat of vision is drawn from the supposed structure of the eye of the cuttle fish. Mr. T. W. Jones has recently made a new dissection and microscopic examination of the eye of the Sepia, in which he finds that the supposed pigment in front of the retina is not really such, but a nervous expansion of a peculiar texture, tinged of a reddish brown color, a circumstance which has given rise to the error of supposing it merely a pigment.—[Lond. and Edin. Philos. Mag., January.]

FOX'S DIPPING NEEDLE DEFLECTOR.—This is a compendious instrument for determining the magnetic dip, intensity, and variation, invented by R. W. Fox, Esq., of Falmouth, England. It consists of a dipping needle accurately poised on an axis passing through the centre of gravity, to be deflected from the position of the dip by two bar magnets fitting into tubes attached to the back of the instrument, and the tubes being capable of motion round the axis of the needle so as to produce a greater or less proximity of the magnets to the poles of the needle. The needle having first been brought into the plane of the meridian, the approximate dip is obscured while the bar magnets or deflectors are not in place.—The plate to which the deflectors are screwed is then moved to make a convenient angle with this dip and the magnets inserted the north pole of one near the north pole, and the south pole of the other near the south pole, of the dipping needle. The needle is thus deflected to a certain angle which is measured. The deflectors are then moved by moving the plate which carries them until they make the same angle

with respect to the first dip, but on the opposite of it. The needle is thus again deflected, but in the opposite direction, and the half sum of the observed angles is the dip. By varying the position of the deflectors several observations may be obtained on different parts of the limb of the instrument, and, with a greater or less leverage, in the force of terrestrial magnetism. The relative intensities are observed by the amount of deflection produced by the magnets at a given angular distance from the line of dip, or by weights p'aced upon a flexible cord passing over a wheel attached to the axis of the needle, either with or without the use of the deflectors. A telescope attached to the plate or arm, carrying the deflectors, serves to determine the variation by a star, or by the image formed by a lens upon a plane of plaster of Paris, when an observation of the sun on the meridian is preferred. The readings of the vertical circle on which the needle plays are made accurate by a second graduated circle, placed near to the front of the box and of course between the eye and the needle. Verniers are provided for reading the angle of the deflectors and the azimuths. The instrument is provided with the usual means of levelling. When packed, the magnets form a circuit, with a view to a permanent condition in the several needles, or bars.—[Ann. Rep. Cornwall Polytech. Soc.]

ON THE PROPERTIES OF LIQUID CARBONIC ACID.--According to M. Thilorier, this liquified gas presents the strange and paradoxical fact of a liquid more expansible than the gases themselves: from 32° to 86° Fahr.. its volume increases from 20 to 29, that is to say, that at 86° Fahr., the increase of volume is nearly equal to half the volume at 32° Fahr. Its expansion is four times greater than that of atmospheric air, which from 32° to 86° Fahr. only expands $\frac{30}{267}$, whilst the expansion of liquid carbonic acid on the same scale is $\frac{116}{267}$. If the temperature of a tube containing a portion of liquid carbonic acid is raised, this liquid boils, and the empty space above the liquid is saturated with a greater or less quantity of vapor according to the elevation of the temperature. At 86° Fahr., the quantity of liquid at 32° Fahr. sufficient to saturate the empty space, is represented by a portion of liquid equal to one third of the space in which the vaporization has been effected. At 32° Fahr. the portion of liquid of saturation is only $\frac{1}{12}$ of the space saturated.

The pressure of the vapor formed by the liquified gas from 32° to 86° Fahr., amounts from 36 to 73 atmospheres, which is equivalent to an increase of one atmosphere for every centigrade degree. It is important to observe that the weight or density of the vapor increases in a much greater proportion than the pressure, and that the law of Mariotte is no longer applicable within the limits of the liquefaction. If the density of the vapor is taken for the base of the pressure, the pressure at 86° Fahr. will be equal to 130 atmospheres, whilst the manoscope will only indicate 73 atmospheres. If a tube of glass containing a portion of liquid and a portion of gas be heated, two contrary effects will take place:

1st, the liquid will augment by expansion;

2nd, the liquid will diminish by vaporization.

The thermoscopic effects are very different according as the portion of liquid is greater or smaller to the portion of gas; the liquid in the tube will either expand, contract, or remain stationary. These anomalies furnished the means of verifying the numbers which the preceding researches had given on the expansion and vaporization. According to these numbers, the points of equilibrium above which the liquid increases, and below which it diminishes on the addition of heat, result from such a proportion when empty or full, that at zero the liquid occupies $\frac{13}{16}$ of the whole tube.—If the liquid at 32° Fahr. occupies one third of the tube it seems as a retrogade thermometer, of which the liquid increases by cold, and diminishes by heat. If the liquid at 32° Fahr. occupies two thirds of the tube it acts as a regular thermometer; that is to say, the liquid increases and diminishes according to the laws of expansion. This thermometer is limited at 86° Fahr. as at this temperature the tube is entirely filled by the liquid.

The specific gravity of this liquefied gas at 32° is 0.83, water being 1. It presents the siugular phenomenon of a liquid which from — 68° to + 86° Fahr., runs through the scale of densities from 0.90 to 0.60.—It is insoluble in water, with which it does

not mix ; but is soluble in alcohol, æther, naphtha, oil of turpentine, and sulphuret of carbon, in every proportion ; it is decomposed in the cold, with effervescence, by potassium ; it does not act sensibly on lead, tin, iron, copper, &c.

When a jet of liquid carbonic acid is directed upon the bulb of an alcohol thermometer, it falls rapidly to — 194° Fahr. ; but the frigorific effects do not correspond with this decrease of temperature, which is accounted for by the almost absolute want of conducting power, and the little capacity for heat, of the gases ; therefore the intensity of the cold is enormous, but the sphere of action is limited in some measure to the point of contact. If the gases have little effect in the production of cold, such is not the case with the vapors, of which the conducting power and the capacity for the heat are much greater. If æther, for instance, could be placed in the same conditions of expansion as the liquefied gas, a much greater frigorific effect would be obtained than by liquified carbonic acid. To accomplish this object it is necessary to render æther explosive, which is easily effected by mixing æther with liquid carbonic acid. In this intimate combination of two liquid, which dissolve one another in every proportion, the æther ceases to be a liquid permanent under the pressure of the atmosphere ; it becomes expansive similar to a liquefies gas, at the same time preserving its properties as a vapor ; that is to say, its conductibility and capacity for caloric.

The effects produced by a tube filled with explosive æther are remarkable ; a few seconds were sufficient to congeal 722 grains of mercury in a glass vessel. On exposing the finger to the jet which escapes, the sensation is intolerable, and seems to extend much further than the point of contact.

M. Thilorier intends to replace æther by sulphuret of carbon ; and it is probable that the effects obtained will be still more powerful.—[Annales de Chimie. et de Phys. and Lond. and Ed. Phil. Mag.]

M. Gambert, the Astronomer, Director of the Marsailles Observatory, and correspondent of the Institutute, died at Paris. This gentleman is well known in the scientific world for his frequent discoveries of comets.

SOLIDIFICATION OF CARBONIC ACID.—M. Thilorier has read to the Academy of Sciences a memoir containing an account of the means by which he rendered carbonic acid solid ; and he also gave some details respecting liquid carbonic acid.

He finds the specific gravity of the liquid acid to be 83, water being 1. ; it dissolves in all proportions in alcohol and æther : potassium decomposes it, but the common metals do not. A jet of carbonic acid, directed upon a spirit thermometer, caused it to fall 194° below zero Fahr. The cold would have been still greater if the bulb of the thermometer could have been entirely covered by the jet.

The solidification of carbonic acid was effected in the following manner : a jet of liquid carbonic acid was received in a glass vial ; the expansion of which it undergoes is about 400 times its original volume, and by this so intense a cold is produced, that one part of the carbonic acid congeals in a white powder and adheres to the glass.—This powder exits for some minutes, and without any pressure. If the finger be placed in solid carbonic acid, the heat converts it into gas, the expansion of which repels the finger. A few grains of this powder, closed in a vessel, soon expelled the cork.

Solid carbonic acid contains a little water, which is doubtless derived from the moisture of the air. In order, however, to remove all doubts, it would be necessary to get rid of the hygrometric moisture, both of the air and of the vessels, because it might be supposed that this water facilitates the congelation of the acid, as in the case with chlorine.

As to the temperature of this congelation, it was determined by using a spirit thermometer graduated to 187° below zero, to which above 44° must be added for the tube of the thermometer, which could not be cooled, so that the cold observed was not less than 231°*.

These experiments were verified by commissioners, among whom were MM. Thenard and Dulong.—[Journal de Chim. Med., tome ii. p. 3. and Lond. and Edin. Philos. Mag.]

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* These are lower temperatures than have ever before been artificially produced, and lower also, we believe, than any which have yet been observed in nature.—ED.

ON THE ELICTRICAL RELATIONS OF CERTAIN METALS AND METALLIFEROUS MINERALS.—Mr. R. W. Fox finds that the crystalized grey oxide of manganese, holds a much higher place in the electro-negative scale than any other body with which he has compared it, when immersed in various acids, and alkaline solutions.—This and some of the other bodies examined by him, rank thus: 1, manganese; 2, rhodium, loadstone, platinum, arsenical pyrites, plumbago, nearly equal; 3, iron pyrites, copper pyrites nearly equal to the second; 4, salina; 5, standard gold; 6, copper-nickel; 9, silver; 8, copper; 9, sheet iron.—[Extract from Trans. Royal Soc. Lond. 1835.]

WATER OF THE ELTON, DEAD, AND CASPIAN SEAS.*—The Elton sea lies to the east of the Volga, 274 versts (181½ miles,) south from Saratov. Its greatest diameter, from east to west, is 17 (11¼ miles,) and its smallest diameter 13 versts, (8½ miles.) The specific gravity of the water, at 53½°, is 1.27288, according to Rose. Its contents are, according to Rose and Erdmann:—

	ROSE.	ERDMANN.
Chloride of sodium,	38.3	71.35
Chloride of potassium,	2.3	
Chloride of magnesium,	197.5	165.39
Sulphate of magnesia,	53.2	18.58
Sulphate of lime,		.36
Sulphate of soda,		3.84
Carbonate of magnesia,		.38
Water and organic matter,	708.7	740.10
	1000.0	1000.00

When the temperature of the sea falls, Epsom salt precipitates. Here it is evident that the specific gravity and composition must change with the temperature. The shore of the Elton sea exhibits, in summer, crystals of gypsum and common salt; and, in winter, besides these, Epsom salt, which, in summer, is again dissolved, so that pure common salt may be obtained here. In the cool summer nights, according to Pallas, Epsom salt is deposited, and is again dissolved during the day. The greater the quantity of chloride of magnesium and Epsom salt, so much the less is there of common salt; which, from the elevation of the temperature, dissolves in no greater quantity in the same. Hence, the reason for the small quantity of common salt which Rose obtained. When an analysis of such a saturated water is given, it is absolutely necessary to give the specific gravity and the temperature. The reasons given are sufficient to account for the difference in the two analysis.

Erdmann found the constituents of the Bogden sea,

Sulphate of lime,	.74
Sulphate of magnesia,	10.30
Sulphate of soda,	215.76
Muriate of lime,	8.85
Muriate of magnesia,	48.53
Water,	715.72
	1000.00

The water of the Elton sea resembles that of the Dead sea, but the latter has a less specific gravity, and a smaller quantity of solid constituents. The quantity of salt diminishes when the Jordan is overflowed. Gay Lussac allowed the water to cool to 19° F. without separating any salt; while Klaproth states, that at the bottom of the flask which contained the specimen which he examined, crystals of common salt were deposited, which soon disappeared. The specific gravity of the Dead sea varies, and the reason is obvious. Macquer, Lavoisier, and Sage found it 1.240; Marcet and Tennant 1.211; Klaproth 1.245; Gay Lussac at 62°.6, 1.2283; Hermbstadt at 60° 1.240. The proportion of ingredients also varies: Gay Lussac fonnd them 26.24 per cent.; consisting of chlorides of sodium, calcium, magnesium, and potassium, and traces of gypsum, differing from that of the Elton sea by the absence of Epsom salt, and the presence of chloride of calcium,

According to Marcet, the specific gravity of the water of the sea of Urmia is 1.16507, and its constituents 22.3 per cent. consisting of common salt, Epsom salt, and sulphate of soda. The saline contents of Urmia and the Dead sea are, therefore, inferior, to those of the Elton sea. Rose has appropriated all the sulphuric acid to the magnesia, because he has found that when common salt and Epsom salt are dissolved in a sufficient quantity of water and evaporated in a summer heat, the two salts separate; and when much common salt is dissolved along with a small quantity of

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* Poggendorff's Annalen xxxv. 169.

Epsom salt, a part of the common salt separates first, and then the Epsom salt, while common salt remains in solution; as by the heat of summer, Epson salt is less soluble than common salt. When the temperature is raised above 122° F. or sunk to zero, in both cases, glauber salt and chloride of magnesium are formed.

Rose found the specific gravity of water brought from the Caspian sea 75 versts from the islands formed by the Volga, at 54½°. 1.0013; and its contents.

Chloride of sodium,	.754
Sulphate of soda,	.036
Sulphate of lime,	.406
Bicarbonate of lime,	.018
Bicarbonate of magnesia,	.440
Water with a small quantity of organic matter,	99.348
	1000.000

[Record Gen. Sc. February.]

RATIONALE OF COLD PRODUCED BY SULPHATE OF SODA AND MURIATIC ACID.—Dr. Kane makes the following statement in a paper on the action of muriatic acid on the sulphates. "It has been long known that Glauber's salt treated with muriatic acid constitutes a powerful freezing mixture, the theory of which is at once explained by the results of the experiment. When sulphate of soda is dissolved in muriatic acid there are formed bisulphate of soda and chloride of sodium, and as the former salt crystalizes with only four atoms of water, the remaining quantity of the water of crystalization of the Glauber's salt, is disengaged to the amount of sixteen atoms." "This large quantity of water suddenly separated from a state of combination in which it had been solid, produces by its absorption of caloric of liquidity the frigorific property."—[Lond and Edin. Philos. Mag. May.]

WEBSTER'S OTAPHONE; OR, PATENT INVENTION FOR ASSISTING THE HEARING.

The inventor was first led to a consideration of this subject by a sensible diminution of the powers of hearing in himself; and observing the general prevalence of this calamity, and also a mode as generally adopted, of applyin the hollow of the hand to the back of the ear to increase the sound, he was induced to consider, whether the assistance this practice afforded, might not be obtained by means less troublesome and unsightly With this view, the instrument he has termed an otaphone was first constructed; and its effieiency having exceeded his expectation, and led to the discovery of further benefits resulting from its use, he hopes that a narration of the principles on which it acts, will induce those who are subjected to the depressing sensation of partial deafness, to avail themselves of it.

The shape of the outward ear generally escapes observation, but if once the attention is directed to it, it will be found to vary in a greater degree than any other organ; and as it is the outwork to the sense of hearing, the recipient from which all the subsequent changes sound undergoes, proceeds, its figure becomes a matter of important consideration, and it is also deserving of remark, whether it always presented the same external appearance.

On inspection of that splendid collection of statuary, forming the gallery of Egyptian antiquities in the British Museum, it will be seen that, in almost every specimen, the ear is represented to have borne, in that remote age, a larger proportion to the head than at present; while in the Grecian and Roman sculpture, produced, probably, at an interval of 1000 years, it in no instance essentially differs from the most elegant proportions amongst ourselves, except in its greater prominence. The angle formed by the helix, or outer margin of the ear, and the temporal bone, varies in these statues from twenty to thirty degrees; and in the female heads, where it is more delicately constructed, a similar projection is observable.

This difference in its development is the more important, if we consider the very peculiar nature of its structure. Being formed of a substance harder than flesh, which would absorb the sound, and softer than bone, from which it would reverberate; having also such irregularities on its surface as collect the vibrations of air in every direction, and convey them to one general receptacle, it becomes apparent that any diminution of its natural expansion must be greatly prejudicial to the purpose for which it seems so wonderfully constructed; a deduction further confirmed by the fact, that those who possess the most perfect and shell-like form of ear, have the sense of hearing in the greatest perfection.

The original shape is still preserved by eastern nations; but the climate we inhabit requiring some covering for the head, both by day and night, has greatly tended to alter its form, and certain notions of taste have induced parents to press it to the head as closely as possible.

This organ seems also to have suffered in another respect,having no longer any voluntary power of motion ; a faculty possessed by the Arabs and other nations approaching nearest to the primitive state of existence, but which long civilization has rendered of less importance to us, and time has nearly obliterated. This adaption of the ears to the direction whence sounds proceed, must greatly increase our auditory perception, and accounts for the wonderful acuteness of hearing possessed by savages. Instances of its existence occasionally occur among ourselves ; a most eminent anatomist having favored the inventor with references to two individuals, who, within the last twelve months, have consulted him, having "a voluntary power over the muscles of the external ear ;" and every practitioner of long standing must have witnessed similar cases.

Sir Charles Bell, in the following extract from his work on the "Anatomy and Physiology of the Human Body," thus speaks of it :—"In most men the motion of the ear is lost, but some still retain it ; and this is very remarkable,—that when the more internal mechanism of the ear is injured, and ceases to strengthen the sound before it conveys it inwards to the labyrinth, the external ear resumes the office *to which it was originally adapted*, and by a degree of motion and erection assists the hearing."

Having thus established both an alteration in the form, and a loss of power in the use of this important organ, it seemed desirable that the projected instrument should not only accomplish the occasional service at first contemplated, but also attempt some remedy to counteract these permanent disadvantages. For this double purpose the otaphones are now constructed. They are formed from a correct model of the back of the ear, and by fitting all the irregularities of that very uneven and elastic surface, gently press forward the parts so as to produce a more perfect orbit, and fuller recipient of sound ; and being self supported, they occasion no inconvenience to the wearer.—By thus concentrating all the powers that nature has provided, a considerable addition to the ordinary force of sound is obtained ; dissipating dullness of hearing, when not arising from internal injury, and enabling those in whom this sense is perfect, to preserve the same advantage at a much greater distance. They will, therefore, be found particularly useful in places of public worship, courts of law, the Houses of Parliament, theatres, and wherever the ordinary powers are insufficient ; and by bringing the focus of sound into a more direct line with the face, the expression of the speaker is better preserved than by the unassisted ear.

It is, however, on the advantages they permanently confer, when their use is discontinued, or very rarely resorted to, that the inventor places his greatest reliance for their general adop ion. Though obtuseness of hearing arises from many causes, one of the most frequent is the insufficient quantity of sound the external ear collects. When this is the case, the membrane of the tympanum, or drum of the ear, and the internal organs which depend on its vibration for their active employment, become relaxed, and contract the same degree of feebleness as would attach to any other part deprived of its natural action ; and this inertness, or stagnation of their powers, renders them unable to surmount those occasional injuries that blows, colds, fever, &c. create ; and thus, from the most common accidents, a permanent injury to the sense is induced, which a more active state of the parts would frequently remove. Ear-trumpets, which are generally employed to remedy this defect, often convey a sound painfully acute ; and instead of bringing this organ, by gentle changes, to a degree of tension to which it might become equal, they commence with a force, derived from metallic surfaces, which impairs its elasticity, and requires the continuance of the same, or a greater power, to preserve any sensation whatever.

The ear therefore seems to require a degree of exercise proportioned to its capacity, but not exceeding it ; and the prevalence of defective hearing leads to the presumption, that a greater nicety is requisite to attain this end, than any artificial means hitherto discovered have afforded. The otaphones are based upon the principle, of proportioning their assistance within the limits apparently asssigned by nature. The alteration they occasion when worn, is but a restoration of the ear to its original and most useful shape ; and for all their subsequent advantages, they depend on that peculiar fabric before described, and which is so happily adapted to the purpose, that no other substance can supply its place. They will, therefore, be found equal to the perfect restoration of the hearing, if any increase of sound, however trifling, is perceptible on their first application, and generally the use for an hour each morning, for a short time, is sufficient ; but if the impediment has been of long continuance, and no advantage on trial is experienced, their employment,without previous preparation, will not be recommended.

In conclusion, it is to be remarked, that as the defect these instruments profess to remedy, arises from insufficient action, and

not from over exertion, they are applicable at every period of life ; while those whose hearing is unimpaired, but desire to hear as well at a greater distance, will at once perceive the advantages they are capable of affording, by the louder sound of their own voices. W.

102 New Bond-street.

From the London Mechanics' Magazine.

DEFEAT OF THE STEAM-CARRIAGES' BILL.

Report from the Lords' Committee appointed to consider the Bill entitled "An Act to Repeal such portions of all acts as impose prohibitory Tolls on Steam-Carriages, and to substitute other Tolls on an equitable footing with Horse Carriages ;" and to report to the House.

Order to report,—

That the Committee have proceeded to the examination of witnesses on the Bill referred to them, and have to report to the house, that the evidence of the principal engineers who have turned their attention to the constrnction of carriages propelled by steam upon the highways proves that very considerable progress has been made towards their perfection, and that they can travel with great rapidity.

The noise and smoke attendant upon their use have been very materially diminished ; but it has been shown in evidence that they still have the effect of terrifying horses, and that accidents have occured in consequence.

Much conflicting evidence has been tendered to the Committee as to the safest shape and the proper limitation of the size of vessels for generating steam to be used in these carriages. All the witnesses, however, agree that in whatever shape the boilers may be made, their size should be such as would in case of explosion not endanger the safety of the public ; and the committee do not feel themselves at present competent to come to such a conclusion on these two important points as would enable them to recommend the necessary enactments, if it was found expedient to proceed further with the Bill.

No adequate means have yet been provided effectually to guard against the emission of sparks from the chimneys of the engines which would guard effectually against the danger arising from them, although, with proper care in the selection and preparation of fuel, it does not appear that the danger is very imminent.

It also appears by the evidence of some of the witnesses examined, that although the management of the carringes is by no means difficult when under the superintendence of an experienced conductor, yet that they require much greater skill than is necessaryon the management of locomotive-engines up in railways : and to find persons properly qualified might be a matter of considerable difficulty.

It is essential that the weight and size of the carringes to be employed should be regulated, so as to prevent their being made of that weight and size which might prove destructive of the roads and a serious nuisance to the public.

It appears also that the tolls intended to be imposed by the Bill are calculated upon an erroneous view of the powers of a horse. The rate of toll is calculated upon the supposition that each horse is able to draw a ton weight ; whereas it is shown that a horse cannot, at a rapid pace, upon ordinary roads draw more than half that weight.

The Committee entertained serious objections to the Bill referred to them ; and they are not of opinion that these objections are counterbalanced by the prospect of any public advantage. The evidence, on the contrary, proves that the proposed mode of conveyance can only be applied to passengers ; and it appears that some experienced engineers, after a careful examination of the expenses attendant upon it, have been induced to abandon all hopes of its success as a profitable undertaking.

It is probable, therefore, that any encouragement on the part of the Legislature would only give rise to wild speculations, ruinous to those engaging in them, and to experiments dangerous to the public. The Committee, therefore, recommend that this Bill should not at present be proceeded with; at the same time, they have no donbt that the further imposition of prohibitory tolls in local acts is not a desirable mode of legislating upon such a subject.

And the Committee have directed the evidence taken before them to be reported to the House, together with the index thereto.

The *Academie des Sciences Morales et Politiques* was on Saturday informed by M. Cousin that he had just discovered some manuscripts, which are important to scholastic and philosophic history. They are writings of Roger Bacon, the celebrated philosopher of the 13th century. Roger Bacon was an Englishman by birth, but passed nearly the whole of his life in France. He became a Franciscan friar, and lived a long time in the convent of the Cordeliers, to which he was confined by order of the General of the Franciscans. This, notwithstanding the silence of Montfaucon and the other bibliographs, induced M. Cousin to believe that there must be manuscripts by Roger Bacon still existing in France. He began by making searches at Douai and

St. Omer, where there were formerly English Colleges. These searches have been successful. The only work of Roger Bacon hitherto known is his first letter to Pope Clement IV., which Bacon entitled *Opus majus*. Clement IV., who protected Bacon, desired that he would give him an exposition of the state of Science in the 13th century. Bacon, receiving no answer to his first letter, addressed a new work to the same Pope, under the title of *Opus minus*. This second letter also remaining unanswered, Bacon remodelled his work, and addressed a third letter to the Pope, which he called *Opus tertium*. The *Opus majus* was published at London in 1733. England possesses a manuscript of the *Opus minus*, and it has hitherto been believed that there was no other in existence. But M. Cousin has discovered at Douai a manuscript containing a considerable fragment of it. This work, in his opinion, is of no great importance. It is not, however, the same with the *Opus tertium*, which may be considered as the last words of Roger Bacon, a manuscript of which has been discovered by M. Cousin, and is the only copy to be found in France. He has, besides, recently discovered at Amiens another manuscript by Bacon, the existence of which has never been suspected. It contains questions on the physics and metaphysics of Aristotle. These three manuscripts, of which M. Cousin is preparing a memorial, will throw a light upon the history of scholastic philosophy, and inform us whether or not Roger Bacon was really, as has been asserted, the inventor of the telescope, the microscope, and gunpowder. This is a question which, for want of authentic documents, it has hitherto been impossible to solve.—[Foreign paper.]

AN ADDRESS TO THE CITIZENS OF HARTFORD, ON THE BIRTHDAY OF LINNÆUS: MAY 24TH, 1836. IN BEHALF OF THE OBJECTS OF THE NATURAL HISTORY SOCIETY; FORMED OCTOBER 8, 1835. BY SAMUEL FARMER JARVIS, D. D., PRESIDENT OF THE SOCIETY, &C., &C.

LINNÆUS.

In 1732, a poor and friendless stranger from a little town in Dalecarlia, presented himself at Leyden to the illustrious Boerhaave. His indigence was so great, that when in college he had been obliged to wear the cast-off shoes of his fellow-students; and though after he had left Upsal, he gained a little money by the practice of medicine, yet by the time he arrived at Hamburg all his resources were exhausted. He persevered, however, in making his way to Holland; and the great physician whom I have named recommended him to a rich proprietor of the name of Clifford, who had a taste of natural history, and possessed at Hatecamp, between Leyden and Hærlem, a magnificent garden, cabinet, and library. In this hospitable abode he remained for three years, enjoying abundantly all the assistance necessary for his favorite studies. Need I tell you that this poor stranger, thus indebted to the munificence and love of science of one rich individual, was the great Linnæus!

In 1735 was published at Leyden, the first sketch of his System of Nature, or the three kingdoms of nature systematically set forth, by classes, orders, genera, and species. It consisted of three tables, each contained in a single sheet; and this, with another treatise of twenty-six pages published the following year, contained the germ of all that he afterward wrote. This work of twenty-six pages, contained, in the form of aphorisms, the theory of botany; and it was the result, as the author informs us, of seven years' study, and the examination of eight thousand plants. It was followed in successive years by three other works, which laid the foundation of the great revolution in botany; and fifteen years afterward, the whole was condensed in an octavo volume, containing proofs in every page of the most subtle intellect, and a most astonishing depth of observation. This single volume has become the fundamental law, the constitution, as it were, of the science; a constitution acknowledged and reverenced by botanists of every nation; and notwithstanding the immense quantity of plants since accumulated, and the innumerable facts which skilful observers have since added, principally on vegetable anatomy and the internal structure of fruits and seeds, his system of Linnæus is even now in full vigor.

It has become, indeed, in some sense, a universal language; and in every country, however remote, where a scientific botanist or even a skilful gardener is to be found, it is sufficient, in order to be understood, to designate a plant by its Linnæan name.—It was not, as we have seen, the discovery of the sexual system which gave Linnæus

his fame and his sovereignty. That discovery is claimed by England; and it preceded the time of Linnæus half a century.—It was rather the distinctness, the regularity, the energetic precision of his system, and especially the convenience of what he called the *trivial*, or as it is now termed, the *specific* name, which gave him this authority. This last simple contrivance alone by which the overburthened memory of the botanist was relieved from the constant accumulation of long descriptive phrases, was found so useful, that, dating from that epoch, he reigned over the botanic world without a rival.

LINNÆRS, BUFFON, AND DAUBENTON.

For nearly a hundred years, the royal garden of plants at Paris, the establishment of which was coeval with that of our city, was greatly neglected, and its revenues were appropriated to other objects.—But in 1732, the superintendence of it was separated from the office of the first physician to the king, and confided to Charles Francois Du Fay, who soon rendered it the finest garden in Europe. He died in 1739, and on his deathbed recommended Buffon as the only man who seemed to him capable of following out his plans. Buffon was a few months younger than Linnæus, and survived him about ten years. Their characters were essentially different. Linnæus was methodical, patient, concentrating, and concise; Buffon despised system, was brilliant and imaginative, diffuse and fond of ornament. Eminently fitted to render a subject popular when the materials were collected and laid before him, he was utterly incapable of that minute, and accurate, and unwearied observation, which are so essential to the science of the naturalist.—Happily he had for his associate Daubenton, whose qualities were precisely those in which Buffon was defective. The collection of facts with which he enriched the history of animals is immense; and the care with which he observed them was so great, that Cuvier has given him a praise, which from any other mouth would have seemed extravagant: *in vain do we look for an error.* He described only what he had seen himself. He did not even draw those general conclusions which most naturally arise from established facts; and his timidity in this respect was so cautious, that Camper said of him, he did not himself know how many discoveries he had made.

It was unfortunate for the interests of science, that Buffon appears to have treated him unkindly in permitting an edition of the History of Quadrupeds to be published, in which the description and anatomy of Daubenton were suppressed. In consequence of this, he refused any further cooperation in the work; and in the history of birds his place was poorly supplied by Guineau de Montbelliard and the Abbe Bexon.

After what has been said of Buffon, it will no longer excite surprise that, in the popular estimation, his fame should so entirely have eclipsed that of Linnæus.—Another cause of his celebrity was, the advantage he possessed in the superintendence of the garden of plants, and the facilities afforded him for forming collections in a city which had become the capital of the scientific world.

Two schools of natural science were now formed; the one pursuing the system of the Swedish naturalist, the other following the more popular course of the brilliant Frenchman.

Time would not permit me to do more than name the individuals who formed these respective schools; and I therefore purposely omit them, lest among so many I should commit injustice by selection.—From 1735 to 1798, when Cuvier published his first work, twenty-eight authors are enumerated on Entomology alone;* each of whom have contributed, more or less, by their observations, to enrich the history of insects. Of these, there were, one Italian, two Danes, three English, three French, three Swedes, three Swiss, four Dutch, and nine Germans. In the other departments, authors have not been so numerous, but the whole science has been carried forward with an impetus truly astonrshing. The French, the Germans, and the English have vied with each other in this generous and noble rivalry.

If the French have surpassed all other nations, it must be attributed to the possession of such a treasure as their cabinet of natural history. It may be said to have been created by Daubenton, and has ever since been continually augmented by the zeal of individuals and the patronage of

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* See Dumeril.

government. Even in the stormy times of the Revolution, when a political frenzy seemed to have seized the whole nation, this splendid monument of science, though for a time neglected, and deprived of its support, was spared, and finally patronized. It was in the spring of 1795 that Cuvier first visited the French capital, and in July of the same year was appointed assistant lecturer of comparative anatomy in the garden of plants. Here, in a lumber-room of the museum of natural history, he found four or five old skeletons, collected by Daubenton, and cast aside by Buffon.

It is interesting to trace from their commencement the history of noble institutions, and to see how much can often be done by the persevering industry of a single individual. These skeletons Cuvier made the basis of his museum, and, encouraged by some professors, though opposed by others, went on in the formation of it with untiring effort. In less than forty years, and within the compass of his own invaluable life, that museum has become one of the wonders of the age, and, together with its immortal author, has created a new epoch in the history of natural science.

GEOLOGY.

The practical knowledge of this branch has been as old as the attempts of man to explore the hidden treasure of the earth; and the regular formation and succession of strata, together with the disturbances occasioned by earthquakes, volcanoes, and inundations, have been remarked at a very early period. The existence, also, of organized bodies in a fossil form, embedded in several of these strata, has been for centuries the occasion of wonder and perplexity. I should weary my readers were I to tell them of all the crude conceptions, and absurd fantasies invented to account for these phenomena. They were such as absolutely to bring geology into contempt; and it was by many regarded as a visionary employment of the human intellect, till the work of Cuvier on fossil organic remains gave it a new character, and produced throughout the world the sensation of a surprising discovery.

The method of considering each separate organ, and tracing it through the whole series of animals, had led him to certain general and invariable laws of combination, by which the possession of one series of bones would indicate the necessary connexion of another series. A beast of prey, for instance, would always have teeth fitted to devour that prey, and claws fitted to seize it. A ruminating animal, on the contrary, would have hoofs instead of claws, and teeth fitted only to grind its vegetable diet. In this way, the possession of even the fragments of an animal would enable him to complete its whole structure, and determine to what genera or species it belonged.

Aided by M. Brogniart, an eminent geologist, Cuvier commenced his researches at Montmartre, and in the quarries of gypsum in the environs of Paris. These had, for many centuries, furnished the building stone of that metrepolis, and had been sunk to the distance of two hundred and 43 Paris feet. About fourteen or fifteen feet below the surfaee, there are strata of marine formations, attesting the presence of salt water, which have altogether a thickness of nearly seventy-seven French feet. Below these incontestible proofs exist of a soil anciently inhabited by quadrupeds of different species, reptiles, birds, and fresh-water fish.—Below these are still deeper strata, containing productions of the sea. By collecting the scattered bones of these animals and reproducing their forms, according to the unerring rules of anatomical science, Cuvier discovered one hundred and sixty-eight vertebrated animals, forming fifty genera, of which fifteen are no longer in existence. Many of the individuals, even of existing genera, are of enormous size; and what increases the wonder, they are such as are now found only in other regions and other climates. No trace was found of human skeletons, or of the order quadrumana.—Almost the entire skeleton was discovered of a species of opossum, an animal which now exists only in America; and this single fact at once overturned the theory, that the American genera had come from their own soil, and had never extended themselves to the other portions of the globe.*

* See the memoir of Cuvier, "Sur le Squelette presque entier d'un petit quadrupede du genre des SARIGUES trouve dans la pierre a platre des environs de Paris," in the third volume of his "Ossemens fossiles." "This rich collection," observes the distinguished discoverer, "of the fragments and skeletons of the animals of a former world is doubtless a wonderful circumstance. It

I shall add no more on this subject, excepting to state, that all the subsequent researches of geologists, of every nation, have confirmed the truth and the importance of this great discovery. The natural evidenees of a sudden and universal deluge, and the probability of the Mosaic chronology, have been set forth with a force of truth which has borne down all opposition ; and although there are still great and very embarrassing difficulties to check the pride of human knowledge, the Christian philosopher is encouraged to wait with patience, till some other bright discovery shall

" Vindicate the ways of God to man."

INFLUENCE OF SCIENCE ON RELIGION.

Finally, let me address you as Christians, and ask, what occupation can produce nobler views of the divine nature and providence than the contemplation of His works ? The pages of inspiration tell us that the invisible things of God, namely his eternal power and godhead, have been clearly seen, since the creation of the world, being understood by the things that are made. It has been objected, I know, that many who have been warmly engaged in pursuits like ours, have, while surrounded by the wonders of creation, been unmindful of the great Creator. That such has been the fact, though to an ex'ent far less than the objection assumes, we are not disposed to deny. We object, however, to the inference which some have thence drawn. We atttribute this result rather to the influence of a little knowledge on the corrupt heart of man, than to the extension of knowledge. We believe that " the knowledge which puffeth up" is eminently superficial ; and in examining the progress of all sciences, we find, that proud presumption may accompany incipid discovery, but that more perfect investigations are invariably followed by profound humillity. Alphonso, of Castile, when th light of astronomical science first dawnec

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has been amassed by nature in the quarries which environ our city, as it reserved by her for the researches and instruction of the present age. Each day we discover some new relic ; each day adds to our astonishment, by demonstrating more and more, that nothing which then peopled this part of the globe has been preserved on its present surface. There is scarcely a block of gypsum in certain strata which does not contain bones. How many millions of these bones have been already destroyed since these quarries have been dug, and this gypsum has been employed in building! How many are, even now, destroyed by mere carelessness ! How many, by their minuteness, escape the observation of the most attentive workmen ! One may judge of this by the fragment I am about to describe. The lineaments there imprinted are so slight, that to detect them we must view them closely.— Yet how precious are these lineaments !— They are the impress of an animal of which we find no other traces ; an animal buried perhaps for thousand of ages, now reappearing, for the first time, to the eyes of the naturalist." He then proceeds, according to his method of induction, to show, in a very clear and satisfactory manner, that it can be no other than the American opossum ; after which he concludes as follows : " I will not dilate upon the geological consequences of this memoir. It is evident to all who are even slightly conversant with the systems relative to the theory of the earth, that it overthrows nearly all of them, in what relates to fossil animals. Hitherto it has been thought that our northern fossils were only of Asiatic animals. It was admitted that the animals of Asia had passed into America, and had been buried there ; but it seemed that the American genera had issued from their own soil, and had never passed into the countries which now form the old continent. This is the second proof" (the Tapir was the first) " which I have discovered to the contrary. And persuaded as I am, of the futility of all these systems, I am happy every time that one of them is destroyed by a well established fact. The greatest service which can be rendered to science, is to clear the ground before we proceed to build ; to begin by demolishing those fantastic structures by which its avenues are choked, and which deter from such occupations those who have happily become habituated, in the exact sciences, to yield only to evidence, or at least to class propositions according to their degrees of probability. With this last precaution there is scarcely any science which may not become almost geometrical. The chemists have lately proved this with regard to their science ; and I hope the time is not far distant when the same may be said of anatomists.' If an apology be required for this long note, I hope it may be found in the interest which every American must feel, in a fact so eventful and extraordinary as that which has given rise to it.

through his instrumentality, on the darkness of his age, could exclaim, that if he had been admitted to the counsels of the Creator, he would have arranged the universe better. He saw that the movements of the heavenly bodies could not be reconciled with what was then supposed to be the planetary system; and instead of doubting the correctness of his own knowledge, he dared to question the wisdom of the Almighty. How different on the mind of Newton was the effect of his sublime discoveries! With what awe do we behold that profound intellect, covering its face with its own wings, like the burning seraphim before the throne of God!* As the occasion of man's fall was an irregular desire of knowledge; so is it a part of that wisdom by which the Almighty seeks to lead us back to our paradise and to his presence, to surround us with wonders which give us constant and inexhaustable subjects of inquiry, and, at the same time, humble us by the perception of how little we can know without his aid.

It is thus with the science of natural history. The farther we advance in knowledge, the better do we perceive how much we do not know, and this perception must forever abase the most profound naturalists. "The minute philosophers," to borrow an epithet of the great Berkley, "may think, for a time, that their boasted discoveries are irreconcileable with revelation. They may raise the sand hills of their systems, and think from them to demolish the fortress of the divine word. Vain and impotent the attempt! Some fortunate discovery, as science advances, demolishes the whole by a single roll of its mighty waters, and the next wave washes it into eternal oblivion. Let us not fear, then, that revelation can ever be seriously assailed, or injured, by philosophy. It may sometimes be wounded in the house of its friends, by too great a degree of sensitiveness, which may prompt them to embrace untenable theories, and distort the language of the bible, to make it accord with what they consider as the result of experiment."*

INFLUENCE OF REPUBLICAN INSTITUTIONS ON SCIENCE.

We boast, and I for one am not disposed as yet to allow that we boast in vain, of exhibiting to the world the grand experiment, such as the world had never before seen, of a people governing themselves. We govern, and are governed, in a manner wholly inexplicable to the theorist of the old world. Not a soldier is to be seen in the wide extent of this immense repub-

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* How sublime is the thought with which Newton closes his treatise on optics! The whole universe, all material things, from comets and planets down to the bodies of animals, the organs of sense and motion, and the instinct of brutes and insects, "can be the effect of nothing else than the wisdom and skill of a powerful everliving Agent, who, being in all places, is *more able by his will to move the bodies within his boundless, uniform censorium, and thereby to form and reform the parts of the universe, than we are by our will to move the parts of our own bodies.*" So in his Principia; "Deum summum necessario existere in confesso est. Et eadem necessitate *semper* est et *ubique*. Unde etiam totus est sui similis, totus oculus, totus auris, totus cerebrum, totus brachium, totus vis sentiendi, intelligendi et agendi; sed more minime humana more minime corporeo, more nobis prorsus incognito. Ut cæcus ideam non habet colorum, sic nos ideam non habemus modorum quibus Deus sapientissimus sentit et intelligit omnia. Corpore omni et figura carporea prorsus destituitur, ideoque videri non potest, nec audiri, nec tangi, nec sub specie rei alicujus corporea coli debet. Ideas habemus attributorum ejus, sed quid sit rei alicujus substantia minime cognoscimus." Lib. iii. De mundi systemate.

* It is refreshing to see that such a mind as that of Cuvier, in a country over which infidelity has swept like the pestilential wind of the desert, could be profoundly philosophical without loseing the sense of its own weakness in the sight of God. Cuvier was a believer, and openly professed his belief. While he sought as a philosopher to pursue the researches of natural science, and to establish results from experiment and observation, independently of the authority of Scripture, it would be vain to seek in his writings any evidence that his experiments or observations shook his faith. If, then, any fact which he has established should seem in any wise inconsistant with the Scripture history, let us wait, and not draw conclusions, till some further accession of knowledge may enable us to see the difficulties removed, and thus convince us that they were formed solely by our own ignorance.

lic, excepting on our frontiers. We govern, and are governed, by the will of the majority. Order is preserved, because it is the instinct of self-preservation; and every man knows, or ought to know, that his life, and liberty, and property is bound up in the life, and liberty, and property of the community.

In Europe, the interest of the whole is made subservient to the interest of individuals. In America, that of individuals is subservient to the good of the community. The interest of society is oftentimes sacrificed in Europe, to promote the interest of the individual; the interest of the individual, on the contrary, may be, and often is, sacrificed in America, to promote the interest of the public.

No doubt these are evils; and they are the evils of opposite systems. In this checquered state of being, where good and evil are the web and woof of the moral texture, the mixture cannot be avoided. It would be out of place for me to say, which system has the most evil or the most good; but let us take our system as it is, and ask whether it excludes scientific improvement? I answer, No. The monarchist of Europe asserts it, but we are not disheartened by the assertion. Our mighty experiment of self-government is far from being exhausted. We have not, it is true, the energy of despotic power which can command schools and colleges to spring into existence, can at once turn the stream of a nation's resources to the formation of cabinets of science, or the fine arts. But we have a nation, every individual of which feels that he is bounded only by the extent of those powers which God has given him; and the very basis of our institutions is, that every member of the republic is under a moral tie, that through him it should receive no detriment. We cannot by decree, transport from distant lands the granite rock, to serve as a pedestal for the statue of an emperor, but we can, by the subscription of a dollar, through the millions of our nation, erect a prouder monument to the memory of our Washington.

To this power, then, we appeal in behalf of natural science; and we ask our fellow-citizens to aid us in the establishment and maintenance of an institution the object of which is to promote the common good, by affording to all the means and opportunities of knowledge.

In our state of society, union is eminently strength; but as it would be vain to talk of colors to one who was born and continues blind, so will it be impossible to produce that union by which society may be exalted and refined, unless we extend the boundaries of intelligence. To dwell on the importance of diffusing a more perfect system of education might seem foreign from the present purpose; yet I may be permitted to quote the farewell advice of him who was first in the hearts of his countrymen, as a maxim of political and moral wisdom. "Promote, as an object of primary importance, institutions for the general diffusion of knowledge. In proportion as the structure of a government gives force to public opinion it should be enlightened."*

I hope that the day may come when, by private munificence, our public institutions shall be so well endowed as to render all instruction gratuitous; when the means of acquiring knowledge shall be as common and as free as the air we breathe; when the poorest member of our community may feel that he has an undivided share in in privileges which ennoble his nature; and when, by the equalizing power of Christian charity, "he that hath gathered much shall have nothing over, and he that hath gathered litttle shall have no lack."

CONTRIBUTIONS OF MISSIONARIES TO NATURAL SCIENCE.

The missionaries sent by the various religious denominations, either into our own territories, or into foreign countries, are, in general, educated men, and may do much to promote the cause of natural science, without any interruption to the duties of their profession. The example of the Roman Catholic missionaries is before our eyes; and the value of their labors in the cause of science is universally admitted. Little is known of China but what has been furnished by them. The French Jesuits, especially, have added greatly to the store of natural knowledge; yet no one can accuse them of neglecting their

* Washington's Farewell Address.

official duties.* Why, then, may not our missionaries, as a useful relaxation from their arduous labors, furnish us with collections, and with much curious information, respecting the natural history of the country in which they sojourn?

* No better example can be given of the acuteness exhibited by the Jesuits in their scientific researches, than the manner in which the Panax Quinquefolium or Ginseng was discovered in America. This plant it is well known, is very highly esteemed for its medical virtues in China, and when prepared by clarification, is worth its weight in silver. As it is in their opinion a panacea, Linnæus gave it the name of Panax. The Jesuits, having been employed by the emperor to draw a map of Tartary from actual survey, arrived in July, 1709, at a village within ten or twelve miles of the kingdom of Corea, and near the mountains where the Gin-seng is found. Father Jartox received four roots from a Tartar, and taking one of them at random, he made an accurate drawing of it, which he sent to his superior in France, together with a map of the country where it grows, between N. lat 39° and 47° and E. lon. from Pekin 10° and 20°. He stated that it grows not in valleys, nor in marshes, nor in the bottom of ravines, nor in very open places, but on the sides of mountains covered with thick forests, around rocks, on the borders of ravines, at the foot of trees, and in the midst of every variety of herbage. If the forest should be consumed by fire, this plant does not reappear till three or four years afterward, which proves that it is an enemy of heat. In fact it conceals itself from the sun as much as possible. "All this," adds Father Jartoux, "makes me believe that *if it can be found in any other part of the world, it must be principally in Canada.*" In consequence of this suggestion, Father Lafiteau, a Jesuit missionary in Canada, was directed to search for it, and with the assistance of the drawings and descriptions of Jartoux, and the aid of the natives, he actually found it. He published an account of his discovery in 1718, and the American root became for a time, till the market was overstocked, an article of great commerce with China, and the source of much wealth. The word *Ginseng*, Jartoux adds, signifies in Chinese, "the representation of a man;" for what reason he cannot tell. The Tartars call it *orhota*, which means "*the first of plants.*" See the original letter in the Lettres Edifiantes et Curieuses, vol. xviii. p. 127, of the new edition, and in the old edition, Tom. x. p. 159. See also Du Halde Hist. de la Chine, where it is copied word for word, vol. ii. p. 150, &c. A good abstract of the whole is to be found in Bigelow's Medical Botany, vol. ii. p. 82–96, and Barton's Medical Botany, vol. ii. p. 191–202. My attention was first directed to this fact by Dr. Barratt,

INTEREST OF EUROPEANS IN AMERICAN RESEARCHES.

That there are many in Europe who are eagar to form a correspondence with Americans, in the hope of exchanging the productions of the old world for those of the new, I can bear personal testimony. In Italy, several distinguished men spoke to me with ardor, and even with anxiety, on this subject. At Turin, the distinguished ornothologist, Bonelli, told me that he could furnish us with all the European birds enumerated by Temmick, if we would send him an equal number of American birds. Bonelli, alas! is no more; but he has left pupils who are following in his steps, and who, no doubt, would be glad to revive his offer. Dr. Grottanelli, of Sienna, offered to furnish us with minerals and plants on the same conditions. The younger Bartelone, of Bologna, would, I have no doubt, undertake the same pledge with regard to insects. In this manner we may, by our own labors, and by this scientific commerce, gradually form a collection the influence of which on the future character of our community, may be more extensive than we have now capacity to calculate. It is only during the feeble period of infancy, that such institutions require to be fostered with peculiar care. That period past, their existence can hardly be called precarious.

FORCE OF THE WATERS.

Extracts from Audubon's Ornithological Biography, Vol. II.

"It was the month of September. At the upper extremity of Dennisville, which is itself a pretty village, are the saw-mills and ponds of the hospitable Judge Lincoln, and other persons. The creek that conveys the logs to these ponds, and which bear the name of the village, is interrupted in its course by many rapids and narrow embanked gorges. One of the latter is situated about half a mile above the mill-

dams, and is so rocky and rugged in its bottom and sides as to preclude the possibility of the trees passing along it at low water, while, as I conceived, it would have given no slight labor to an army of woodsmen or millers to move the thousands of large logs that had accumulated in it.—They lay piled in confused heaps to a great height along an extent of several hundred yards; and were in some places so close as to have formed a kind of dam. Above the gorge there is a large natural reservoir, in which the head waters of the creek settle, while only a small portion of them ripples through the gorge below, during the latter weeks of summer and in early autumn, when the streams are at their lowest. At the neck of this basin, the lumberers raised a temporary barrier with the refuse of their sawn logs. The boards were planted nearly upright, and supported at their tops by a strong tree extended from side to side of the creek, which might there be about forty feet in breadth. It was prevented from giving way under the pressure of the rising waters by having strong abutments of woodland against its centre, while the ends of these abutments were secured by wedges, which could be knocked off when necessary. The temporary dam was now finished. Little or no water escaped through the barrier, and that in the creek above it rose in the course of three weeks to its top, which was about ten feet high, forming a sheet that extended upwards fully a mile from the dam. My family was invited early one morning to go and witness the extraordinary effect which would be produced by the breaking down of the barrier, and we all accompanied the lumberers to the place. Two of the men on reaching it threw off their jackets, tied handkerchiefs round their heads, and fastened to their bodies a long rope, the end of which was held by three or four others, who stood ready to drag their companions ashore in case of danger or accident. The two operators, each bearing an axe, walked along the abutments, and at a given signal knocked out the wedges. A second blow from each sent off the abutments themselves; and the men leaping with extreme dexterity from one cross log to another, sprung to the shore with almost the quickness of thought. Scarcely had they effected their escape from the frightful peril that threatened them, when the mass of water burst forth with a horrible uproar.

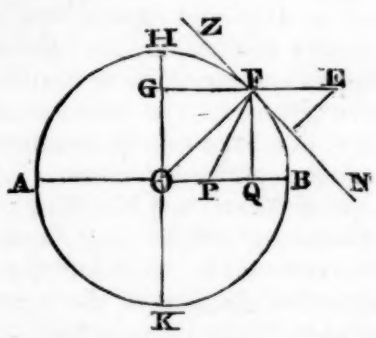
All eyes were bent towards the huge heap of logs in the gorge below. The tumultuous burst of the waters instantly swept away every object that opposed their progress, and rushed in foaming waves among the timber that every where blocked up the passage. Presently a slow, heavy motion was perceived in the mass of logs; one might have imagined that some mighty monster lay convulsively writhing beneath them, struggling with a fearful energy to extricate himself from the crushing weight. As the waters rose the movement increased; the mass of timber extended in all directions, appearing to become more and more entangled each moment; the logs bounced against each other; thrusting aside, demersing, or raising into the air those with which they came in contact: it seemed as if they were waging a war of destruction, such as ancient authors describe the efforts of the Titans, the flamings of whose wrath might to the eye of the painter have been represented to the angry curlings of the waters, while the tremulous and rapid motions of the logs, which at times reared themselves almost perpendicularly, might by the poet be taken for the shakings of the confounded and discomfitted giants. Now the rushing elements filled up the gorge to its brim. The logs, once under way, rolled, reared, tossed and tumbled amid the foam, as they were carried along. Many of the smaller trees broke across, from others great splinters were sent up, and all were in some degree seamed and scarred. Then in tumultous majesty swept along the mingled wreck, the current being now increased to such a pitch that the logs, as they were dashed against the rocky shores, resounded like the report of distant artillery, or the angry rumblings of the thunder. Onward it rolls, the emblems of wreck and ruin, destruction and chaotic strife. It seemed to me as if I witnessed the route of a vast army, surprised, overwhelmed, and overthrown. The roar of the cannon, the groans of the dying, and the shouts of the avengers, were thundering through my brain; and amid the frightful confusion of the scene, there came over my spirit a melancholy feeling, which had not entirely vanquished at the end of many days. In a few hours almost all the

timber that had lain heaped in the rocky gorge was floating in the great pond of the millers ; and as we walked homewards we talked of the Force of the Waters."

PAPER ON ANALYTIC MATHEMATICS, BY PROF. T. STRONG, READ BEFORE THE MECHANICS' INSTITUTE, JUNE 7, 1836.

The following ingenious piece of analysis is from the pen of Professor Strong, of Rutgers College, N. J., and was obligingly furnished in answer to an inquiry that was made of him.

In Enfield's Philosophy, in the scholium to prop. 158, in astronomy, there is a *geometric* demonstration of what is here proved by a very complicated as well as ingenious *analysis*. The angle here obtained is about 5′; (see scholium above referred to,) and it should be borne in mind that all Mr. Strong attempts to do in this case is, to arrive, as he actually does, *analytically*, at what is proved in Enfield *geometrically*. The angle in question, however, is gotten by taking other circumstances into consideration ; and is thus found to be about 11′. After explaining the principles by which this latter value of the angle is obtained, Mr. Strong introduces what he has to say upon Enfield, by the obvious remark, that "The result there obtained is on the hypothesis that the whole attraction of the earth is towards the centre ; that is to say, that the attraction of the centre is infinite, when compared with that of any of its parts. So that we may consider the whole attraction as constant at any point of its surface, and directed toward the centre. To illustrate this,



let A K B H denote a section of the earth through its axis H K. Then if we suppose the earth to be a solid of revolution, we shall have its figure by supposing A K B H to revolve about H K, regarded as fixed. To find the figure of the meridian, A K B H, on this hypothesis, we proceed as follows :— Let F denote any point in the arc, H B, and Z N, a tangent at the same point. Put O B $=a$; O G $=x$; and G F, drawn perpendicularly to H K $=y$. Still further, put A = the constant attraction towards the centre, and f the centrifugal force at B, the equator. Then O B : F G : : or $a : y : : f : \frac{fy}{a}$ = the centrifugal force at F ; which acts from G toward E ; and this resolved in the direction of the tangent, gives $\frac{fy}{a}\cos$ E F N, which tends to move a particle at F towards the equator; Again, A is the attraction from F toward O . and, by supposing O B greater than O H, the angle O F Z, will be evidently acute. So that by resolving A in the direction F Z, we shall get A· cos O F Z, for the force which tends to move a particle at F toward the pole H. Hence, in the case of an equilibrity of the particle, we must have $\frac{fy}{a}$ cos E F N = A. cos, O F Z (1). Now G F Z $= \frac{dx}{dy}$ which is written with the sign—because x decreases, while y increases. So that by trig. $\frac{1}{\sqrt{\frac{dx^2}{dy^2}+1}} = \cos$ Z F G = E F N. — Also the angle O F Z = O F G + G F Z ; and tan. O F G $= \frac{x}{y}$ So that we have by the formula for the tangent of the snm of two angles, $\frac{\frac{x}{y}+\frac{dx}{dy}}{1+\frac{x\,dx}{y\,dy}} = \frac{x\,dy+y\,dx}{y\,dy-x\,dx} =$ tan. O F Z. So that

$$(1+\tan.^2\ \text{O F Z})^{\frac{1}{2}} = \frac{\sqrt{(x^2+y^2)\cdot(dx^2+dy^2)}}{y\,dy+x\,dx}$$

= Sec. O F Z. And since the reciprocal of the secant = cosine, we get cos. O F Z $= \frac{y\,dy+x\,dx}{\sqrt{x^2+y^2}\cdot\sqrt{dx^2+dy^2}}$. Hence, by substituting the values of the cosines in (1), we shall get

$\frac{f\,y}{a\,\sqrt{\frac{d\,x^2+1}{d\,y^2}}}=A.\frac{y\,d\,y+x\,d\,x}{\sqrt{x^2+y^2}.\sqrt{d\,x^2+d\,y^2}}$;

or $\frac{f\,y\,d\,y}{\sqrt{d\,x^2+d\,y^2}}=A.\frac{a}{\sqrt{x^2+y^2}}.\frac{y\,d\,y+x\,d\,x}{d\,x^2+d\,y^2}$;

or $f\,y\,d\,y=A.\frac{a}{\sqrt{x^2+y^2}}.(y\,d\,y+x\,d\,x)$ (2).

If now we suppose f to be extremely small in relation to A, it will be obvious that A K B H will differ but little from a circular. So that by neglecting indefinitely small quantities of the second order of minuteness, we may suppose $\frac{a}{\sqrt{x^2+y^2}}=1$ in equation (2); and then that equation will become $f\,y\,d\,y=A.(y\,d\,y+x\,d\,x)$ (3). Now the integral of this last equation is $f\,y^2+C=A.(y^2+x^2)$ (4). And to determine C, which is the correction in this case, put $x=0$; and then $y=a$; and thus equation (4) will become $f\,a^2+C=A\,a^2$. So that $C=a^2\,(A-f)$; and hence (4) becomes $(A-f)\,a^2=(A-f)\,y^2+A\,x^2$ (5); and this is the equation of an ellipse whose semi-axes O B and O K are respectively a and $a\,\frac{\sqrt{A-f}}{\sqrt{A}}$. So that O B : O K : : $1:\frac{\sqrt{1-f}}{\sqrt{A}}$ or $\frac{1-f}{2A}$ nearly. Now by putting $\frac{f}{A}=\frac{1}{289}$, which is the ratio of the centrifugal force at the equator to that of gravity there, we have $1:\frac{1-f}{2\,A}::1:\frac{1-1}{578}$: : 578 : 577. And hence O B : O K : : 578 : 577. Through F draw F P perpendicular to the tangent meeting O B in P; and also draw F G perpendicular to O B; and then F P B will equal the apparent latitude of F; and F O P will=the reduced latitude; and the difference of these will=P F O, the reduction of the latitude. Now making F Q, radius, we get P Q : O Q : : cot. P : cot. O. But Hutton's conics, prop. 17 of the ellipse, we have P Q : O Q : : $\overline{O\,K}^2:\overline{O\,B}^2$: : A—f : A : : 288 : 289. So that if F O P=51° 46′, we shall have 288 : 289 : : cot. 51° 46′ : cot. 51° 40′ 17″ nearly. So that O=51° 40′ 17″; and hence 51° 46′—51° 40′ 17″=0° 5′ 43″= the reduction P F O, which agrees very nearly with the result in Enfield."

From the London Mechanics' Magazine.

LONDON AND BIRMINGHAM RAILWAY.

REPORT OF THE DIRECTORS TO THE SIXTH HALF-YEARLY GENERAL MEETING OF THE PROPRIETORS, HELD AUGUST 5, 1836.

The Directors have the satisfaction to announce to the Proprietors, that the progress of the works generally, in the last six months, has been such as to warrant the expectation which was held out at the last meeting, that the whole line will be completed by the summer 1838, and the first twenty-one miles from London in the spring of 1837.

Of the Primrose Hill Tunnel, which is 1105 yards long, only 114 yards remain to be made; the Kensal Green Tunnel is finished, and traversed by the Company's locomotive engines; 1423 yards are completed of the Watford Tunnel, the total length of which is 1793 yards; and the difficulties which were presented by the quicksand in the Kilby's Tunnel have already been so far surmounted, as to leave no doubt in the mind of the Company's engineer, that they will not delay the opening of the railway beyond the time mentioned. With reference to the other portions of the work, the Directors are making every exertion to forward them, so as to give the Proprietors the benefit of a revenue at the earliest possible period; satisfied that although for the attainment of this object an additional charge will be incurred by the Company, the advantage to be derived from it will be more than commensurate to the expense.

The Directors have entered into a contract, under the guarantee of two responsible sureties, with Mr. Edward Bury, of Liverpool, an able and experienced builder of locomotive engines, for the conveyanco of passengers and goods, on tho railway, by locomotive power, to whatever extent may be required, at a fixed rate of remuneration; the Company providing engines of Mr. Bury's specification, and Mr. Bury, on his part, maintaining and keeping them in repair; the contract to be in force for three years from the opening of the railway.—The Company have thus assured to themselves the advantage of locomotive power at a uniform and moderate rate, and under a system of management which it is the in-

terest of the contractor to render mutually beneficial to the Company and himself.—The Directors have also contracted for such locomotive engines as will be first wanted, and for a portion of the carriages.

The Directors in referring to the Bills for railways, connected with the London and Birmingham, which have received the Royal Assent in the present Session, feel themselves called upon to congratulate the Proprietors on the great accession of traffic which they may anticipate from the direct communication opened with the northern and eastern parts of the kingdom, by means of the Midland Counties, North Midland, and Birmingham and Derby Railways, not to mention the connection between Birmingham and Gloucester, by the Birmingham and Gloucester Railway, nor minor lines, which will all contribute to swell the revenue of the Company. Acting upon the suggestion of the Proprietors at the last General Meeting, and considering it desirable that a connexion should be secured with Leamington and Warwick, the Directors have instructed the Company's engineer to ascertain the levels for a branch line to those places, to join the London and Birmingham Railway near Coventry; and they have also set on foot the usual investigation into the traffic, so as to be prepared to follow up the object with such measures as may, in the opinion of the Proprietors, be deemed expedient.

By the statement of accounts now to be laid before the Proprietors, it will appear that

	£	s.	d
The receipts to the 30th June were	1,955,608	0	5
The disbursements . . .	1,492,100	16	8
That the balance in favor of the Company was, at that date . . .	463,507	3	9

And that the amount received on loan, pursuant to the powers given by the last General Meeting, was 443,800*l.*

It is estimated that the liabilities of the Company, for the next six months, will be sufficiently met by the cash at their disposal, and by loans which have been tendered and agreed for, with the addition of calls. Great as the present scale of expenditure will appear, the Directors are satisfied that so long as the works proceed with energy proportioned at that expense, the Proprietors will hail the increase as an additional evidence of the approach of their great undertaking to completion.

APPLICATIONS OF CHEMISTRY TO THE USEFUL ARTS, BEING THE SUBSTANCE OF A COURSE OF LECTURES DELIVERED IN COLUMBIA COLLEGE, NEW-YORK, BY JAMES RENWICK, PROFESSOR OF NATURAL EXPERIMENTAL PHILOSOPHY, AND CHEMISTRY.

VII.

USEFUL APPLICATIONS OF THE EARTHS.

1. LIME.

PREPARATION OF QUICK LIME.

AUTHORITIES.—DUMAS. Chimie appliqué aux Arts.
BISTON Manuel du Chanfournier

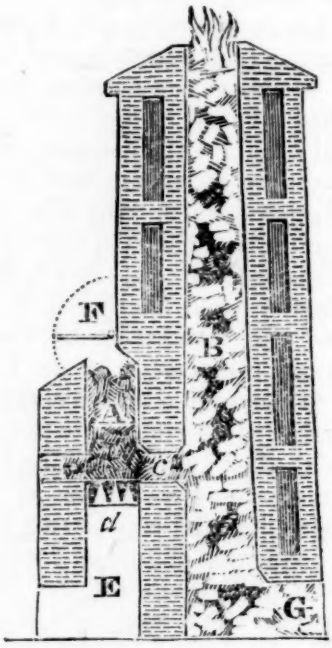
Under the general name of limestones are comprehended all mineral substances which contain not less than half their weight of carbonate of lime. Quick lime is prepared from most of these limestones, by calcination, and is characterized by the property of absorbing water with phenomena of heat, an action which, if it also cause the lime to fall to powder, is called slaking. Lime prepared from different varieties of limestone has different properties in this respect. In some cases the action is rapid and violent, the heat produced, great; in others the operation is more slow. and the heat less intense. There are also, limestones which after calcination will not slake. The limestones which are richest in carbonate of lime belong to the first variety; those which contain carbonate of magnesia in a proportion greater than 10 per cent. to the second; while the resistance to the action of slaking in the third is due to the presence of argillaceous matter. The two first varieties are alone suited to the preparation of mortar. The last variety will not make mortar in the usual manner, but is nevertheless of great value as an ingredient in cements which will resist the action of water. In the act of slaking, quick lime, which retains after calcination the shape and structure of the limestone whence it is prepared, falls, as has been stated, to fine powder. It also falls to powder after exposure to the air, when it is said to be air slacked. In the first case the lime combines with water forming a solid hydrate; in the latter i-

absorbs carbonic acid from the atmosphere, and returns to the same chemical state which the limestone possessed before calcination.

The calcination, or, as it is usually styled *burning* of lime, is performed in chambers built of stone, which go by the name of kilns. Of these there are two descriptions, ordinary and perpetual. The ordinary lime kiln is of the shape of a truncated cone, or of a portion of an ellipsoid. The limestone is prepared for calcination by breaking it into pieces none of which have a greater dimension than 3 or 4 in. cube. The larger fragments of limestone are employed in building a rude vault, over a cavity left in the lower part of the kiln. To this cavity an entrance or door is left in the wall of the kiln. The rest of the kiln is filled up with smaller pieces. When wood is used as fuel, it is introduced by the door into the space beneath the vault and is burnt on the floor of the kiln. When coal or turf are employed, an iron grate is provided, on which the fuel is placed, leaving an ash-pit beneath. In building the vault, the spaces between the stones are left of as great an area as possible, and in filling the kiln the largest of the remaining pieces are laid next to the vault, while the smallest fragments are used for covering the rest, and closing the top of the kiln

The fire is at first moderate, in order that the limestone may be gradually heated. After 10 or 12 hours the quantity of fuel is gradually increased, until the mass of limestone is brought nearly to a white heat. After it has been kept for some hours at this temperature, the bulk of the mass of limestone decreases about one sixth, and flame issues almost free from smoke, from the top of the kiln. The intensity of the heat is then gradually diminished until the fire is permitted to extingush itself, for want of fuel. In order to complete the calcination of a given bulk of limestone in an ordinary kiln, nearly three times its volume of wood, or twice its volume of turf or coal is required. Much of this quantity of fuel is consumed in the gradual heating of the limestone and in preventing it from cooling too rapidly after the calcination is complete. It is therefore obvious that in a kiln in which the operation might be kept up without ceasing, a considerable saving of fuel might be ensured. Such a kiln is said to be perpetual. The first attempt at the construction of a perpetual kiln was made by Count Rumford. Its construction and use will be understood from the annexed plate. Pl. 1.

Plate 1.



A. Furnace
B. Body of the kiln.
C. Flue by which the flame and heated air passes from the furnace to the kiln.
d. Grate.
E. Ash-pit.
F. Iron Door.
G. Opening by which the lime is removed.

The furnace being charged with fuel and lighted, the door F, and the mouth of the ash-pit are left open until the fuel is ignited. The mouth of the ash-pit is then closed, and a draught will be directed downwards through the fuel into the body of the kiln, and carry the smoke, flame, and heated air through the limestone which it contains. That which is completely calcined is removed at the opening G, and its place supplied by limestone thrown in at the top of the kiln. In consequence of the air being drawn downwards through the burning fuel, the smoke is almost wholly consumed.

An improvement in the kiln of Rumford was made by Monteith of Closeburn in Scotland, but although more effectual and convenient, the cost of its construction would forbid its being brought into common use.

The consumption of the smoke, which is the distinctive character of these two kilns,

is of little value in this case. Hence, various kilns have been contrived in which the draught of the fire places is not inverted, and these are placed in the circumference of a circle round the body of the kiln It is unnecessary to describe the kilns of this character, for a far simpler form has been found sufficient, wherever coal or turf can be employed as a fuel. The kiln to which we refer has the form of an inverted truncated cone whose height is twice as great as the diameter of its greater base. A few faggots or billets of wood are placed in the bottom of such a kiln, and set on fire. These are covered with coal, and when the latter is fully ignited, the kiln is charged with alternate layers of limestone and coal, until it is filled to the top. The combustion gradually extends itself through the several beds of coal. When the calcination is completed, two thirds of the charge are withdrawn from the lower part of the kiln, which is then filled up with fresh layers of limestone and coal. In this way the consumption of coal does not exceed one fourth of the bulk of the limestone calcined. Fuel also of a very inferior description will answer the purpose of lime burning in the last mentioned kiln, as, for instance, the refuse cinders of bituminous coal, and the screenings of anthracite. A kiln of this construction is represented pl. 2.

Plate 2.

Fig. 1.

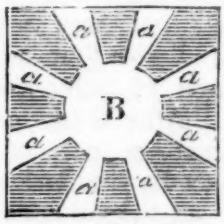


Fig. 2.

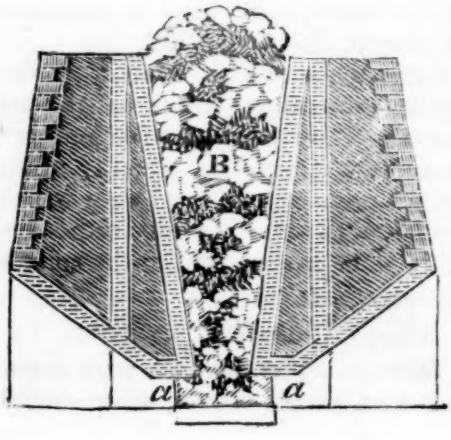


Fig. 1 is a ground plan, fig. 2 a section.

B. Body of the kiln.

a, *a*, *a* opening through which the lime is received.

PREPARATION AND USES OF MORTAR.

Rationale.—When the hydrate obtained by slacking quicklime is mixed with water to the consistenee of paste, a small portion of the lime is dissolved ; the dissolved lime attracts carbonic acid from the atmosphere and is precipitated upon that which remains undissolved, the water is thus left free to dissolve a new porton of the lime which is in its turn precipitated, and this successive action will be continued so long as moisture is present, or any portion of quicklime remains. The cessation of the action arises more usually from the loss of moisture by evaporation, than from the complete solution of the quicklime. A portion of the latter therefore remains, which is gradually converted into carbonate, and thus the semiliquid paste is gradually converted into a white solid possessing but litlte adhesion. If silica be mixed with the lime and water, the precipitation of the carbonate takes place upon it in preference, and the adhesion between them is stronger than in the former instance. Indeed, it appears as if the chemical affinity which exists between lime and silica influences tle adhesion, and that the conversion of the carbonate into silicate of lime begins, and continues to go on for ages. It is only in this way that we can account for the long series of years which elapses before mortar attains its limit of hardness, and a force of aggregation often superior to that of the limestone whence it is made. The theory of the formation of a silicate of lime is also corroborated by the act, that even in the most ancient and hardest mortars, the quantity of carbonic acid which is present is always less than would be required to convert the lime into carbonate. For the same reason that the adhesion of the precipitated carbonate of lime to silica is greater than to other portions of llme or carbonate, the adhesion of mortar to brick or siliceous stones is greater than to limestone. It is however necessary in all cases that the stone or other material which is to be laid in the mortar be moist, or at least do not absorb moisture. If the material absorb water from the mortar, the solution and precipitation no longer take place, and no

adhesion will ensue between the mortar and the stone. In laying brick, therefore, it is necessary that it be wet before the mortar is applied, otherwise no bond will take place.

Preparation.—The lime intended for the manufacture of mortar should be either recently burnt, or should have been carefully preserved from the action of air.

Lime which has been long slaked will make as good mortar as recent quicklime, provided the latter condition have been attended to, but as it is more difficult to judge of the freedom from carbonic acid in slaked than in quicklime, it is considered preferable to use the latter rather than the former.

When the lime is prepared from a stone which is free from impurities, it slakes readily, and may be converted into mortar as the art of slaking is going forward. For this purpose, a sort of basin is formed on the ground, by means of the sand intended to enter into the composition of the mortar. The lime is thrown into the middle of this basin, and water gradually poured over it. The quantity of water must be sufficient not merely to form the solid hydrate, but to convert it into the mechanical mixture known as the milk of lime. As the quicklime falls to powder, it is gradually incorporated with the sand and water by means of a hoe, which is also of use in breaking down those parts of the lime which longest resist the action of the water.

If the lime be combined with magnesia, it slakes too slowly to permit this method to be employed. Such lime should be placed in a conical pit, water thrown upon it, and then covered up with the sand intended to be mixed with it. Days, or even weeks may elapse, before the whole mass shall have fallen to powder, but after the disintegration is complete, such lime will make as good a mortar as that prepared from a pure carbonate. It is more usual to slake such lime in the neighborhood of the kiln, and to separate the parts which have not fallen to powder by means of a screen, but this method is objectionable, as the finer and richer portions are liable to be charged with carbonic acid before they can be transported to the place where the mortar is to be prepared. A method which is preferable to either consists in plunging the magnesian lime into a vessel of water, where it is permitted to remain until completely pulverised. The excess of water is then drawn off, and the lime with the residue of water incorporated with sand. The sand which is to be used in making mortar, ought to be made up of angular fragments of quartz. Such sand is found in the bed of running streams, or in diluvial and alluvial deposites from running water. It is designated by masons by the epithet sharp. A mixture of argillaceous matter deprives it of this quality, but as this may be separated by agitation with water, the necessary sharpness may often be acquired by washing the sand.

For laying brick or well jointed stone, fine sand is to be preferred; for common hewn stone, sand of coarser grain; and for rubble work, the mortar made with coarse sand should be mixed with small pebbles, or rather with angular fragments of a siliceous stone.

The best proportion of the materials of mortars, is one part of a pure quick lime to three of fine or four of coarse sand. If the lime be of less purity, the quantity of sand must be lessened in such manner as to bear the same proportion to the pure earth contained in the limestone.

The rapidity with which mortar sets may be much increased by the use of quicklime, ground to powder, instead of being reduced to that form by slaking. This method is the invention of Loriot, a French engineer, who supposed he had discovered the secret of the hardness of the ancient mortars. He directs that three parts of slacked lime be mixed with four of water, and that sixteen parts of pulverised brick or sand be added. After these materials are thoroughly mixed one part of quicklime ground to fine powder is to be added. This mortar has not all the valuable properties which were anticipated by its inventor. It might however, be used to advantage in building in frosty weather.

Limestones which contain silicoous or argillaceous matter are fit for the preparation of mortar, so long as the lime prepared from them retains the property of slaking, but the proportion of sand with which they can be mixed must be still further lessened by the bulk of the other earths contained in the limestone.

HYDRAULIC CEMENT.

History.—The ancients were acquainted with a substance which, when mixed with

a pure quicklime and water, formed a mixture that possessed the property of hardening under water. This is a volcanic product having the form of powder, originally found at Puteoli in the neighborhood of Vesuvius, and called from the locality *Terra Puteolana.* The material is still used on the shores of the Mediterranean and is called Puzzolana

The wants of the people of the Low countries led them to seek in their own vicinity for a substitute for Puzzolana. This was found in a rock furnished by extinct volcanoes, whose traces are to be seen on the banks of the Rhine. This differs from Puzzolana in requiring a calcination to prepare it for use, and when calcined it absorbs moisture so readily that it must be carefully preserved from contact with the air, unless it be used within a short time of its manufacture. During the sixty years war, the people of Holland were cut off from a supply of this important article. In order to replace it, earth was drawn up from bottoms of their canals, formed into brick, burnt, and pulverized. This article was found to be nearly as efficacious as the native product, and both go by the common name of Terras or Trass.

Not only is there a substance which when mixed with pure lime makes an hydraulic cement, but these are varieties of limestone, which are characterized by refusing to slake when water is poured upon them, that when mixed with sand have the same valuable property. The discovery of this property seems to have been accidental and its date unknown. Such limestones were first worked at Aberthaw in England, and Salenches in France. When the construction of the New-York Canals was commenced, such limestones were found in its vicinity, and since that period quarries of the same description have been opened in various parts of the United States. It may indeed be inferred that there is hardly any calcareous formation some of the layers of which do not possess this property.

Even where native puzzolana, Terras, or an hydraulic lime are all wanting, the example of Holland shows that artificial substitutes may be found wherever clay can be obtained.

Of all the materials for the preparation of an hydranlic cement, those which contain within themselves all the necessary substances, and thus require no foreign matter to be mixed with them, seem to be best. Such are the septariæ found in the London Clay and used in the preparation of "Roman cement."

Rationale. If the scale of a smiths forge, or the black oxide of iron in any other form, is mixed with common mortar, it acquires the property of setting more rapidly, and speedily becomes so hard as to resist the action of watar. Clays rich in ferruginous matter, if burnt and reduced to powder, have the same effect upon lime. It was also found that the native Terras contained from 10 to 15 per cent. of oxide of iron. It was inferred from these facts, that the property possessed by a cement of setting in water, was due to the presence of oxide of iron. Some of the most valuable hydraulic limes however, contain little or no iron, and Puzzolana is also poor in that substance. An isolated observation subsequently led to the ascription of the hydraulic property to the presence of oxide of manganese. Another view of the subject led to the hypothesis that hydraulic cement was obtained from a sub-carbonate of lime, the limestones from which it was prepared being in such a state of combination that heat could not expel more than half their carbonic acid. The theory which is now received is that of Vicat, who infers that hydraulic cement is obtained, whenever a silicate of lime is either formed in the calcination of the limestone, or generated rapidly by the action of the substances with which a pure lime is mixed. This silicate has the property of combining readily with water, and then the aqueous part of the cement speedily becomes solid. To this we may add that the ternary compounds of silica are formed with more readiness than the binary, and thus metallic oxides, alumina, and probably other earths concur in hastening the formation of the solid hydrated silicates.

PUZZOLANA.

Authority.—Belidor. Architecture Hydraulique.

Hydraulic cement may be made of puzzolana, by mixing nine measures of a pure quicklime, or an equivalent quantity of that which is less pure, with water, and twelve measures of puzzolana, and six measures of good sharp sand. If the place where it is to be employed in the

erection of masonry is so situated that the stones may be laid above the level of water, no other preparation is necessary than in the use of common mortar. If it is to be used below the usual level of a mass of water, a coffer dam may be constructed. This is a case formed of piles and pile-plank driven into the bed of the mass of water, in such manner as to resist its passage. After the coffer dam is finished, the water inclosed within it is raised by a pump, or other appropriate hydraulic engine, and the work is performed, after the water is thus discharged, precisely as if it were common masonry. When the bed is level, or can be rendered so, a caisson may be employed. This is a water-tight vessel whose bottom is flat, and whose sides are vertical. It is made large enough to contain the proposed structure and at the same time have room for the workmen and necessary scaffolding. The caisson is buoyant, and floats at the surface of the water. The building materials are introduced into it, and covered up in regular courses from its bottom. As the work advances the caisson sinks, until it rests upon the bed. After the structure has been raised above the level of the surface of the water, the sides of the caisson may be removed, but the timber bottom remains as a foundation for the masonry. Stone may also be laid in hydraulic cement beneath the surface of a mass of water by means of the diving bell.

A more rapid mode of construction was employed by the ancients, and is still used in the ports of the Mediterranean. Instead of a tight coffer dam, a mere inclosure of woodwork is formed in the water, inclosing a space of the figure of the contemplated structure. To 27 measures of hydraulic cement, made as has just been described, 16 measures of pebbles or chip stone are added, and the whole incorporated by stirring it for an hour, either with a hoe in the hands of a workman, or by the aid of machinery. The mixture is then formed into a conoidal heap, and allowed to remain at rest until a hard crust is formed on its surface. This will happen in warm dry weather in five or six hours, but in moist weather, some days may elapse before the cement acquires a proper degree of consistence. The mass is then broken up by the pickaxe, and intimately mixed for the second time by agitation. No water need be added to the mass, but it will regain its fluidity by stirring. When the water in which the structure is to be built is deep, the mixture is plunged into it by means of a wooden case of cubical shape. This is managed by means of a windlass moveable upon a railroad, and has a sliding bottom, or a shutter fastened by hinges. When this has been lowered until no more space is left than just suffices for the opening of the shutter, the latter is permitted to open, and the cement falls to the bottom. A second case full is lowered and deposited beside this, and the surface of the two masses leveled by rakes and other appropriate instruments. When a uniform bed, of about a foot in thickness over the bottom of the whole space inclosed by the wooden partition has been thus deposited and spread, blocks of stone of not more than eight inches cube are thrown upon the cement, until an entire layer of such stones has been spread over the cement, in which they are capable of partially embedding themselves by their own weight. Upon these a second layer of cement is spread by means of the case, which is followed by a second layer of stones, and thus the level of the surface of the water is reached. The case however becomes uesless when the depth of water is less than twice the vertical dimension of the case. After the structure has been raised thus high, the cement is thrown in by baskets and hods, and the last courses may even be laid by the trowel.

In Europe, the wood which encloses this structure is usually removed, and may be employed again for the same purpose, but when wood is abundant, it would probably be better to leave it as a protection to the structure, until it decays, when the masonry will probably be perfectly consolidated.

Terras both native and artificial may be used in the same way. So also may the powder of burnt clay or brick, of calcined ochre, and roasted clay slate.

Terras is prepared from a columnar greenstone or trap rock found near Andernach on the banks of the Rhine. This is roasted and reduced to powder. A similar stone is found on the bank of the Hudson near Fort Lee, and might no doubt be used for the same purpose. Other varieties of trap rock or basalt may be prepared for a simi-

lar use, by heating them until they begin to fuse, and grinding them to powder.

Hydraulic Lime.—Hydraulic lime is calcined in the same manner as common limestone. It is prepared by grinding it in a mill to a fine powder, and ought to be kept for use in tight casks. Any limestone which contains from 9 to 10 per cent. of argillaceous matter is slightly hydraulic, and it possesses this property in perfection when the proportion of that compound amounts to 20 or 30 per cent.

An artificial cement may be prepared by mixing 3 parts of chalk with one of clay, tempering the mixture with water, forming it into bricks, calcining, and grinding to powder. Care must be taken, that, while the heat must be sufficiently intense not only to drive off the carbonic acid from the chalk, but also the last portion of water from the clay, the mixture does not begin to fuse, for, after this stage is reached, the hydrate can no longer be formed.

It was long supposed that the hydraulic limes and artificial cement could not be used in building in a mass of water, by throwing in loose stones upon a bed of cement mixed with chip stone, as described under the head of puzzolana. But recent experiments in France have shown that this idea is unfounded, and that the hydraulic limes mixed with common sand, have all the properties of the cements of which puzzolana or terras form a portion. It is necessary however, to examine experimentally the length of time which they take to set beneath the surface of the water, for this will differ with the different varieties of the natural mineral; and where the rate of setting is not such as to render the mixture hard within a few hours, the mixed cement and chip stone must be allowed to lie in heaps until it becomes hard at the surface, before it is plunged into the water.

Roman Cement.—This celebrated article is prepared in England from a stone found in nodules in the geological formation called the London clay. It is a compact substance of a brown color, susceptible of high polish It is usually divided into irregular masses by veins of crystalized carbonate of lime. The quantity of silica and alumina contained in the brown portion is sufficient to form the cement without any further addition, when it is to be used beneath the surface of water. When thus unmixed it will set, either in the open air or in contact with water, in not more than fifteen minutes. Its properties in the two cases are however different, for it does not, if used unmixed, increase in hardness after it has once set, when merely exposed to the air; but if immersed in water, or in a damp position, it gradually acquires the firmness of the strongest native limestone. It should therefore never be employed pure, except when it is to be exposed to the action of water. Where it is used merely in a moist place, two parts of good sharp sand should be mixed with three of cement; if in a position exposed to frost, three parts of sand to two of cement; while in a dry and warm climate or in covering walls exposed to the sun, at least five parts of sand should be mixed with two of cement. It is probably owing to the Roman cement, when applied as a stucco, having been used pure, and laid upon dry brick, that its use has been attended with little success in this country, for when properly prepared and applied, it has borne equally well the extreme climate of Canada, and the torrid air of the West Indies. Its use also requires an experienced workman. When it is to be mixed with sand, the two materials must be thoroughly incorporated before water is added.

A stone, identical to that which the Roman cement is prepared, has been found at Boulogne, in France, and one similar in texture, and in being veined with carbonate of lime, at Cumberland in Maryland. The poor calcareous ores of iron, found in coal formations, have also been used in preparing a cement, which has all the properties of the Roman, and goes by the same name. The material whence Roman cement is prepared has also been used in England in the preparation of artificial stone. For this purpose the cement while still liquid is poured into moulds having the figure of architectural ornaments. A similar use has recently been made of the American hydraulic cements, under the sanction of a patent.

USE OF LIME IN AGRICULTURE.

(*a*) There are certain soils which contain inert animal or vegetable matter, which being insoluble is unfit for the food of plants. Quicklime has the property of hastening the putrefactive process, and will thus, by disposing the inert matter to en-

ter into fermentation, render it capable of supporting the growth of plants.

(*b*) Some soils are charged with a small quantity of acid matter, which interferes with vegetation, except that of a few useless plants. This acid may be neutralized by lime, which may either be applied in the state of quicklime or of carbonate.

(*c*) Sandy soils may be barren in consequence of the rapidity with which moisture escapes from them; and clay soil in consequence of its forming tough clods in dry weather, and being too retentive of moisture. Both of these opposite defects may be remedied by lime, for this earth renders the toughest clay friable, and causes sand to be more retentive of moisture. Quicklime will act most powerfully in both these cases, but the carbonate is not inefficient.

(*f*) The seeds of the cereal granima all contain lime in combination with acids. Their stalks also contain it, but in less proportion. Wheat is the grain which contains most of this earth. Hence none of these valuable vegetables will flourish except in soils which contain lime, and some soils which are fertile in grass, may be incapable of bearing grain; or those which yield a tolerable product of the less valuable grains, may refuse to bear wheat. As the lime enters into the constitution of the plants, the calcareous matter of the soil will be gradually exhausted, and hence it has been found that even under careful management, wheat has gradually ceased to be a profitable crop in the older parts of the United States. Animal manures contain the phosphate of lime, and thus convey to the soil some of this earth, but not in quantities sufficient to maintain a soil in condition for wheat. Carbonate of lime ought therefore to be applied from time to time, or slacked lime spread upon the ground, and ploughed in, after it has attracted carbonic acid from the air.

(*g*) Lime and its carbonate have also the property of condensing the gases which arise from putrefying vegetable and animal substances, and of combining with other products of their decomposition. Hence the native fertility of calcareous soils will continue much longer than that of other descriptions, and the effects of vegetable and animal manures will be more permanent if applied to a soil containing lime, or in combination with that earth or its carbonate.

In England and Scotland, as much as 400 bushels of slacked lime have been advantageously applied to clay soils, and 200 bushels to sands. In this country the use of lime has been chiefly confined to the farmers of German origin, in Pennsylvania, and their descendants in other States. The proportion has rarely exceeded 40 bushels per acre; but while in England the effect of the larger quantity lasts for more than the life of man, the less quantity in America is renewed as a preparation for every wheat crop.

The best mode of applying lime is that practised in La Sarthe, (France.) Here, slacked lime, in the proportion of no more than 12 bushels per acre, is made into a compost with sods.

Pulverized limestone may be used for most of the purposes for which slacked lime is applied, for, except when it is wished to promote the decomposition of inert organic matter, or to render a clay soil speedily friable, the caustic earth is unnecessary, and occasionally injurious; but it is generally cheaper to reduce limestone to powder by calcination and slacking than by mechanical means. In Europe, however, chalk is used as a manure.

The true marl, or mixture of carbonate of lime and clay, is also a valuable manure, as are the shells found in the green sands of the seaboard of the United States, which are improperly termed marls.

The magnesian limestones ought, if calcined, to be applied with great caution, as magnesia when deprived of carbonic acid is destructive of vegetation, and as it attracts that acid from the atmosphere much less rapidly than lime does. In small quantities, however, or if exposed until the whole of the magnesia has been carbonated, the magnesian limestones yield a valuable manure.

Lime, even if pure, must be applied with caution to soils which have never before been subjected to its action. The dose may be increased at each successive application, and it is more efficacious, and may be applied in greater quantities, when animal or vegetable manure is used at the same time. But it must not be mixed previously with stable or barn-yard manure, as much of the value of that substance will bd destroyed by the rapid decomposition indu-

ced by lime. This rule does not apply to carbonate of lime, and therefore marl, in particular, may be mixed to great advantage with dung-hills, and used to form a bed in barn-yards, for the purpose of absorbing liquid manure, and the gases generated in the putrefaction of the litter.

From the Richmond Whig.

COPPER IN VIRGINIA.

The copper region of our State is beginning to excite a great deal of interest throughout the country, and it is a subject well worthy the attention of scientific and practical men. The importance of this subject will readily be perceived, when we recollect that the demand for copper is almost unlimited, and constantly increasing, arising from the new uses to which it is almost daily being applied, and that copper mines are among the most certain and profitable of all mines. The last annual report of the consolidated mines in Cornwall, states the value of the products of that mine, for the last year, to be (£152,000) one hundred and fifty-two thousand pounds sterling: they employ three thousand five hundred laborers, and steam power equivalent to seven or eight thousand horses, and are now working at the depth of more than 1600 feet below the surface. The average yield of the ore from that mine is between 8 and 9 per cent. of copper. The analysis of the copper ores of this State show them to be much richer, and lying nearer the surface, they can certainly be worked to much greater profit. There are two copper mines in this State, one called the United States, situated in Orange county, and the other the Phœnix Mine in the county of Fauquier, which are attracting considerable notice. There has as yet been but little work done at the United States, but a company has been recently organized and will speedily commence operations, under what are believed to be very favorable auspices. The Phœnix Mine was worked to considerable extent, many years since, by an English company and a large quantity of ore taken from the mine, and shipped to Europe. That company were forced to abandon the enterprise owing to the impossibility of keeping under the water with the imperfect machinery of that early day. A party of gentlemen have recently undertaken to work this mine. An engine has been erected to free the mine of water, which it easily accomplishes: skilful miners have been employed, and it is hoped the work will be prosecuted with vigor. The ore taken from the mine since the present company have commenced operations, is very rich and beautiful, and the prospects on the whole are very flattering. They have unwatered the mine, and ascertained that the vein is of regular formation and sufficiently large.

We have seen in this city specimens of the ore of the Phœnix Mine, and they are of extreme wealth undoubtedly. They are now undergoing analysis by Dr. Johnson, and we may state the result at an early day.

The early history of the Phœnix Mine is curious. It was worked some 15 or 20 years before the Revolution, and the ore sent to England to be smelted. Its richness may be conjectured from its bearing transportation across the Atlantic, and still paying profit.

There is, we are happy to say, a deep interest beginning to be taken in the mineral wealth of Virginia, and a spirit of active enterprise displayed in developing it. For the gratification of the curious, and in the hope of impelling forward the spirit now awakened, we throw together the following *data* as indicating the value of the Phœnix Copper Mine. They have been prepared on careful inquiry, and we believe may be received with confidence.

1. It is proved that there is a regular well defined vein the absence of which, it is believed, has prevented the success of any copper mine yet undertaken in America.

2. This vein is from two to five feet in width, which in Cornwall would be considered very considerable.

3. The vein cuts the formation at a high angle, and when that is the case, it never gives out in depth.

4. No reliance can be placed upon any mine, however favorable the superficial indications, when the existence of a regular vein cannot be demonstrated.

5. The vein is not only free from any admixture which might injure the copper, or render its reduction difficult, but actually contains an abundant quantity of limestone, the substance employed for its flux.

6. The ore is exceedingly kindly and rich, and will bear comparison with specimens from the famous mines of Cuba and Chili.

7. Considerable quantities of ore have been taken from the mines and shipped to Europe, as is proved by the refuse left on the surface, and the testimony of numerous traditions.

8. In England, few copper mines are productive for the first few hundred feet, whereas this one has yielded much fine ore about that of fifty.

9. The present formation, which is intersected by the vein, is superficial. This is the opinion, expressed with great confi-

dence, of Professor Rogers, who states that the copper has come from beneath where the regular mineral formation will be found, after penetrating through the upper horizontal strata.

10. The vein is probably of desirable length, as specimens of ore have been found upon its course at a considerable distance in both directions.

11. The property includes nearly a mile upon the supposed course of the vein.

12. The existence of a branch at the depth of fifty feet makes it probable that there are other veins—parallel veins. It is rare that a single issolated vein is found.

13. The mine is but 25 miles from tide water, and four from a canal now in process of construction.

14. There are roads and settlements, and above all, abundance of wood in the neighborhood.

15. The mine is in actual operation—a steam engine and ample mining materials are upon the spot, and an opportunity will soon be furnished of obtaining any additional machinery of the most improved kind in the immediate neighborhood.

CURTIS'S CHIMNEY-HOOD AND ASH-PAN FOR LOCOMOTIVE-ENGINES.

SIR,—I send you a drawing and description of my chimney-hood and ash-pan for locomotive-engines, as used on the London and Greenwich Railway, and shall feel obliged by your insertion of the same in your valuable pages.

The Hood —The chimney of the engine is covered with a dome, which projects the steam and heated air escaping into the atmosphere upon a surface of water contained in the receiver or outer vessel, so that any sparks or other matter ejected from the chimney must necessarily be received in the water, and consequently extinguished. The condensation of the steam, together with the priming of the boiler, supply sufficient water to keep the bottom of the receiver always covered; and for the purpose of carrying off any excess of water, a small tube is fixed to the bottom of the receiver, and this pipe stands up about $1\frac{3}{4}$ of an inch, so that a plate of water of $1\frac{1}{4}$ inch deep is always ensured. The pipe enters the chimney and forms an elbow, which elbow also is always full of water, so that no fire can possibly pass through it. It is my intention eventually to form the dome double, and to pump up the cold water, which will be thus heated by the waste steam, and then to pump this heated water into the boiler, thus converting the apparatus into a feed head. I find a space all round of about four inches sufficient for the passage of the steam, &c. I have put this invention to the most severe tests I could devise, but could never force a spark from the chimney. The engine runs freer and faster than with the gauge, the draught is unimpaired, the apparatus is cheap and simple, and absolutely safe.

Fig. 1. *Fig.* 2.

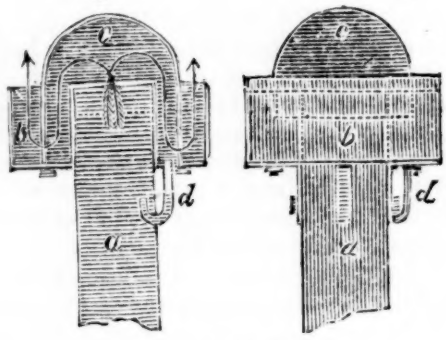


Fig. 3.

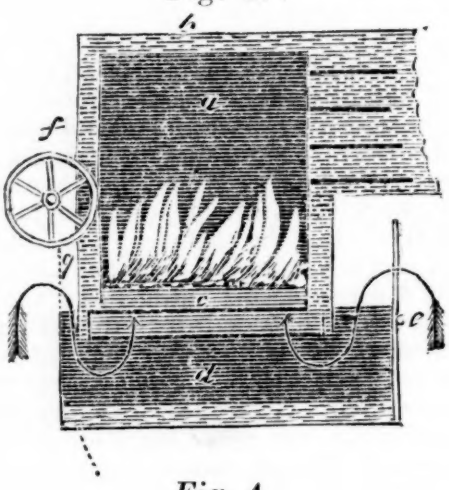
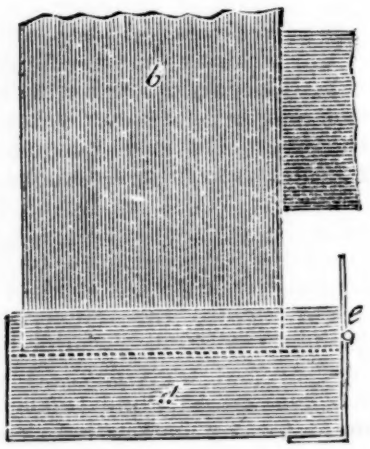


Fig. 4.



Description of Engravings.

Fig. 1 is a section, and fig. 2 an elevation of the hood: *a*, chimney; *b*, receiver, containing water; *c*, dome or hood; *d*, bent

tube; the curved arrows show the path of the steam, air, &c.

The *ash-pan* is a box of sheet-iron suspended under the fire, and water-tight, so that the water filtering through the fire-box *a* is received into it The pan is about eight inches deep, and the sides rise above the fire-box about three inches all round, so that the dust in the act of falling is not blown away during the progress of the engine, or by the wind, and being received into water is, of course, immediately extinguished, while the water is evaporised; and the vapor not only prevents the coke from clinkering on the bars, but materially assists the combustion. The box is open all around and behind about eight inches, thus providing abundant aera for the passage of the air to the fire. It is suspended behind by a joint to the framing, and before by a chain which coils round the axle of the hand-wheel *f*, so that when the engineer wishes to discharge the ashes, or rake the fire-bars, he merely lets go the wheel, when the pan falls down, describing the curve shown by the dotted line.

Description of Engravings.

Fig. 3 is a section, and fig. 4 an elevation of ash-pan and part of the boiler: *a* fire-box; *b*, boiler; *c*, fire-bars; *d*, ash pan, containing water; *e*, hinge of ditto; *f*, hand-wheel; *g*, chain by which the pan is suspended. The curved arrows indicate the path of the air.

Your most obedient servant,

W. S. Curtis.

Deptford, August 6, 1836.

From the Scotsman.

CAPTAIN S. BROWN'S METALLIC LIGHT-HOUSES.

It has been proposed to place a lighthouse on the Wolf Rock, near Land's End, a position where it would be exposed to the most violent storms of the Atlantic; and a plan was drawn up for the purpose by Mr. Stevenson, who holds a high rank in this department of engineering; which plan, Mr. Brown thinks, would require fifteen years for its execution, and cost £150,000. Mr. Brown undertakes to erect one of bronze, 90 feet high, which would answer the purpose as well as the stone one of 134 feet, for £15,000, and to complete it in four months. Lighthouses are generally of masonry, the outer stones clamped with iron, and in large blocks, to lessen the number of joints. The one on the Eddystone Rock, near Plymouth, erected by the celebrated Smeaton, is 24 feet in diameter at the base, and 90 feet in height, of which 72 consists of solid masonry. That built by Mr. Stevenson on the Bell Rock, near Arbroath, is 40 feet in diameter at the base, and 110 feet in height, of which 102 consists of solid masonry. The defects of such a structure are obvious. In the first place, it consists of some thousand pieces; and, among as many thousand joints in it, a few faulty ones would be fatal to its strength. Secondly, its great breadth presents an enormous surface to the action of the winds and waves. Mr. Brown estimates, from experiments made by him at the extremity of Brighton Chain Pier in a heavy south-west gale, that the waves impinge, on a cylindrical surface of 1 foot high and 1 foot in diameter, with a force equal to 80 lbs.; to which must be added that of the wind, which, in a violent storm, exerts a pressure of 40 lbs. He computes the collective impetus of the wave on the lower part of Mr. Stevenson's proposed lighthouse for the Wolf Rock, of the surf on the upper part, and of the wind on the whole, to be equal to 100 tons. On the bronze column of 90 feet, which Mr. Brown, proposed to to substitute for the stone structure, the pressure, calculated in the same way, would be only 6½ tons. The natural height of the wave in a storm is supposed not to exceed 18 or 20 feet; but the *surf*, which is, we suppose, half water and half spray, rises, at times, above the head of the Eddystone column, *hooding* the lantern in a watery coat, and sometimes extinguishing the lights. It unfortunately happens, that adding to the height of the column scarcely produces any greater security to the lights; for, as the breadth must be increased with the elevation, the surf, instead of splitting and passing of by the sides, as it would do upon a smaller column, just mounts so much higher, having a greater susface to resist its onward movement. At the Bell Rock, which is not exposed to such heavy seas as the Eddystone, the surf in a storm mounts to the lights, which are 100 feet above the ordinary level of the sea. At such times, the column is felt to *tremble* when struck by the huge mass of rolling waters; and the keepers, perched like two sea-mews on the top of a beacon staff, with nothing but the raging elements around them on all sides, feel their situation (as they confess) very forlorn, and naturally think of the sins of their past life.

Mr. Brown's proposed metalic lighthouse is 90 feet high, 14 feet in diameter at the bottom, and 4 feet at the thinnest part. The lower half called the base, is in four pieces, each piece consisting of a portion of a hollow cone (or paraboloid,) wider below than above, and about ten feet high; the lower piece is sunk 3 feet into the rock,

and is fourteen feet in diameter at its under margin; the fourth piece is six feet in diameter at the top. These four pieces fit into each other, the neck of the lower passing into the socket of the upper, and both being secured by flanges; so that the joints are, in some degree, stronger than the entire part of the shaft. Above these is the smaller part of the shaft, which is in three pieces of nearly the same length, and fitted in the same manner. Above this, the shaft widens out into an inverted cone, which forms one piece, and supports the more important parts. These, are first, the keepers house, which is 8 feet in diameter, and 7 feet high, with a gallery round it, "for lookout, and walking exercise." Next the lantern 9 feet wide and 10 feet high to the cupola, for containing the lights. The house or sitting room, is made of two concentric cylinders of sheet copper, 9 inches asunder, to equalize the temperature, and attached to each other by rivets; it is formed into compartments for bookcases, shelves and lockers, with a recess for the back of the stove. Immediately below the house, in the swell of the shaft, are the sleeping-berths. To complete the description of the column, we shall add, that the upper section of the base contains two tanks, one for oil, and one for fresh water; the next section, above, is for coals and provisions; and the one above that, a general store. Access is obtained from below by the chain ladder reaching down to the sea; and by ladders in the inside, by which the keepers mount to their ærial abode. The whole work, 90 feet high, would cost £16,000 or £17,000, if entirely of bronze; £11,300, if the base were bronze, and the upper part cast-iron; or £9000, if entirely of cast-iron; and it would be erected in four months.

The advantages of this plan of Mr. Brown are the following:—1. The expense of erecting lighthouses is much diminished, so that six may be erected for the sum now spent on one. 2. The time necessary for building them is contracted from years to months; and the chances of loss of life in the progress of the work are proportionably diminished. 3. The bronze lighthouse, from the slenderness of its shaft, and the smallness of the resisting surface, will not carry the wave and spray half so high as the stone lighthouse; and, with two-thirds the elevation, it will afford equal protection to the keepers and the lights. 4. From this slenderness, and its diminished height, the strain of the surge and winds upon it, in a storm, will not exceed one tenth of what a stone structure is exposed to. 5. It has but8 joints from the bottom to the lantern; while the stone lighthouse has thousands; and the bronze joints admit of being made as strong as the entire part of the shaft. 6. That its separate portions, being complete circles, cast solid, each is *per se*, capable of resisting any lateral impulse of the water whatever,and the column only can be injured by a transverse pressure operating upon its length. 7. That the cohesion of the materials, or the power of the column to resist fracture by a transverse strain, is probably a hundred times as great as in an equalcolumn of stone. 8. That the natural stability of a bronze column, derived from downward presure, must be considerably greater than that of stone. In addition to this source of strength, the column is to be secured 10 feet into the rock by numerous bolts; so that it cannot be removed, without carrying all that body of rock along with it, which would require a pressure of several hundred tons.

As to the durability of bronze in water, when proper precautions are adopted, two letters are given from Mr. Brande and Mr. Faraday, which remove every reasonable doubt. Both of them think that cast-iron might answer sufficiently well for the upper part of the column. Nothing is said about the chances of injury from lightning; but the tower, being entirely metalic, it would act, we suppose, as a very perfect conductor, and convey the electricity to the earth without injury to the keepers. Bronze is an alloy of copper and tin. We should have observed that, in Mr. Brown's opinion, a bronze column could be erected on a sand-bank, by piling, or by a different process, which he describes, and where a stone structure would be impracticable.

The situation of the keepers in one of Mr. Brown's lighthouses is one of the most singular which the multifarious occupations of human life present. The stone tower, though really less secure, has an appearance of solidity, which goes some length to satisfy the imagination; but Mr. Brown's watchmen are suspended in mid-air, on the top of the pillar, whose slenderness, compared with its length, reduces it to the appearance of a small rod. Cooped up in a cage, one half of whose narrow floor projects over the sea, or standing on a gallery which hangs over it completely, they live for months together without exchanging words or thoughts with their fellow mortals. There they pass the dark and stormy nights, with the winds howling, and sea birds shreiking around them, while the abyss foams and rages below, and the slender stem that bears them above it quiv-

ers under their feet when struck by the angry surge, or beaten by the tempest. No situation can be conceived more dismal and monotonous, more beset with terifying circumstances, or better calculated to impress the mind with a constant feeling of insecurity. Such, however, is the force of habit in reconciling men to outward circumstances, which appal at first sight, and to real and formidable dangers too, that there is never any want of candidates for the most hazardous employments; and no difficulty is, we believe, apprehended in getting sober considerate persons to commit themselves to these sea-girt ærial cradles; nor any doubt felt, that, after a month's experience they will sleep secure in them, though lullabied by storms and tempests, the aspect of which, in such a situation, would drive a greenhorn landsman mad.

To understand the importance of lighthouses, it may be proper to state, that the number of British vessels shipwrecked annually is about 550, or *one and a half per day*. The average burden per ship of the mercantile navy is about 110 tons; and, if we value old and new together at half the price for building, or 5*l* 10s per ton, we have £600 for the value of each, and £330,000 for that of the whole; which may be reduced to £300,000, by deducting the value of the sails, masts, and other materials. saved from some of those stranded. If we add an equal sum for the value, of the cargoes, the whole loss from shipwrecks will be £600,000 per annum. This statement proceeds on an old estimate from 1793 to 1829; Mr. Maculloch says, in the *Supplement* to his *Dictionary*, that the number of ships lost, or driven on shore, in 1833, was on less than 800. It is probable, then, that the anuual loss by shipwreck is not much short of a million sterling. If one fifth part of this loss could be prevented by additional lighthouses, the saving in money would amount of a million in five years, to say nothing of the still more important saving in human life.

RAILWAY TRANSIT AND INLAND NAVIGATION.

(*From the Times' Report of First Days's Proceedings of the Bristol Meeting of the British Association, August* 22, 1836.)

The subjects arranged for discussion were two—on certain points connected with the theory of locomotive carriages, and on the application of our knowledge of the phenomena of waves to the improvement of the navigation of shallow rivers and canals.

Professor Mosley opened the first point by stating that there were many gentlemen present acquainted with the practical working of steam engines, but the relations between the theory and practice were not perfectly understood. The piston of a locomotive engine was pressed on either side, one resulting from the friction on the road, and the other from the passive friction of the engine itself. If it was lifted from the ground, a person endeavoring to move the wheels would find a resistance equal to 150 lbs. The cause of the resistance was this —that the traction upon the engine induced additional friction of the machinery, and that probably was one fifth of the whole amount of friction. If the engine moved without a train, there would be a passive resistance; if a train was attached to it, there would be induced a considerable friction of the machinery. There were, in fact, three causes of resistance—the friction of the carriage, the passive resistance, the additional friction by the train—the first and last varying according to the weight of the train. On the other side there was the expansive force of the steam. The quantity of work done was greater as the velocity was less. Inclined planes on railroads he considered to be injurious.

Dr. Lardner said he had given a good deal of evidence before Parliament upon this subject. In all inclined planes more steep than the angle of repose there was an unfavorable loss of power. The portion of mechanical force expended in ascending the plane was not repaid in the descent.—Theoretically they might take advantage of the accumulative matter as a deposit of momentum, and make a perfect mechanical compensation, but that was not the case in practice, because they were obliged to check the velocity in the descent. He had never said, as had been represented, that inclined planes were not of importance, because the friction in the ascent was given back in the descent. When the engine was descending, great part of its steam was going off in the safety-valve, therefore inclined planes were injurious. All the experiments led to the conclusion, that every effort should be made to attain as perfect a level as possible. Every departure from a level, though it saved a quantity of capital in the construction of a road, entailed an everlasting expense. The re-

sult of some experiments he had made was this--that in the ordinary state of the roads, the force necessary on a level was 7 lbs., per ton. but he found an extraordinary difference depending on the state of the rails, a difference amounting in some instances to such an extent that the friction was reduced to 4 lbs. When it rained and the rails were wet, he found the friction reduced to 4 lbs., but as soon as the rails became again dry, the friction was again 7 lbs.; he should therefore suggest, that two watering-pots should be placed before the wheels, so as to give the engine an additional power of nearly 50 per cent. There was another point with regard to dust: he had let himself down a very steep inclined plane, and when he attained a speed of 60 miles an hour, he had a quantity of sand put on the rails, and the consequence was, that the steam engine came to a stop.

As to the second subject for discussion--namely, "On the application of our knowledge of the phenomena of waves with a view to the improvement of the navigation of shallow rivers and canals."

Mr. Russell made some very lengthy, but very interesting observations, the substance of which was this,—where canals did exist, there was no man but wished they should be conducted in the most profitable manner. Newton's law had been confirmed, that the resistance was in proportion to the square of the velocity. The difference in the amount of resistance between a veesel drawn on a canal by a horse, trotting or cantering, was from 108 to 136. He would read from a paper the results of various experiments he had made, in which they would perceive a very curious fact as regarded the pace of eight miles an hour.—The table was thus:—

				lbs.
4	miles an hour	gave a resistance	of	33
6	ditto	.. ditto	..	91
7½	ditto	.. ditto	..	265
8½	ditto	.. ditto	..	215
9	ditto	.. ditto	..	235
11	ditto	.. ditto	..	246
12	ditto	.. ditto	..	352
15	ditto	.. ditto	..	444

But at the rate of 20 miles an hour the vessel skated along the surface of the water, and there was scarcely any resistance at all. When a vessel was propelled at a great velocity and then stopped, it produced a wave varying in its form, according to the mass of the water, and he had followed such a wave a mile and a half; the velocity of the wave was uniform, and independent of the velocity of the vessel. If the vessel was going four miles an hour, this wave would go at the rate of eight miles an hour, and he had seen a large wave overtake a small wave and pass it. The waves never exceeded in height the depth of the quiescent water. Vessels at a slow velocity did not divide the water as was generally supposed, but pushed it forward in the shape of a wave; but where the velocity was greater than eight or nine miles an hour, the vessel did divide the water. It was possible to bring the vessel completely upon the wave, and then you had scarcely any resistance. A velocity of between four and six miles an hour on canals was unprofitable; beyond 11 miles an hour you had a high velocity, and comparatively little resistance. He recommended a rectangular canal where it was intended the velocity should be great, as by widening a canal with sloping banks you increased the resisting power.

The Rev. Mr. Whewell agreed with Mr. Russell in nearly all his remarks, which he considered most valuable and important to be considered. It was clearly ascertained that the greater the velocity the less the resistance.

Mr. Russell felt convinced that by adopting a considerable velocity, the Atlantic might easily be crossed with steam-vessels.

The Chairman (the Marquis of Northampton) said, that the observations of Mr. Russell were most important, and that the gratitude of the country was due to him for his experiments.

ARSENIC.—M. Schweiger Seidel has invented a very simple method of ascertaining the presence of arsenic in food, &c. however small the quantity may be. He puts a portion of the matter to be tried, and double its weight of soda, into a little glass tube; he closes the open extremety of the tube with blotting paper, and heats the other end with a taper: the arsenic is sublimated in a few moments, and adheres to the sides of the tube in the part which is not heated.—[Atheneum.]